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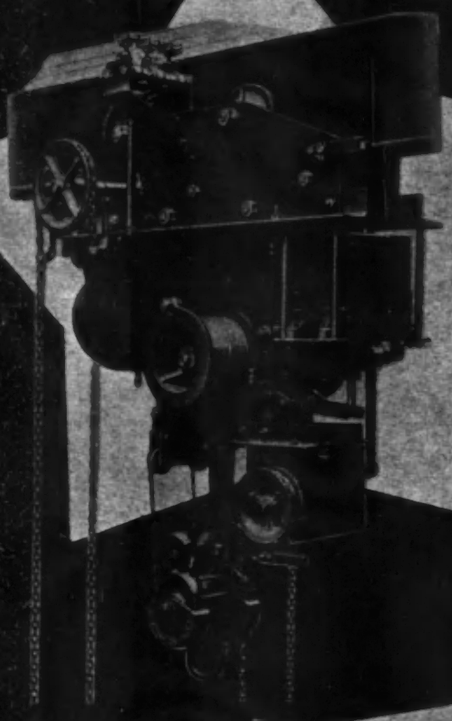

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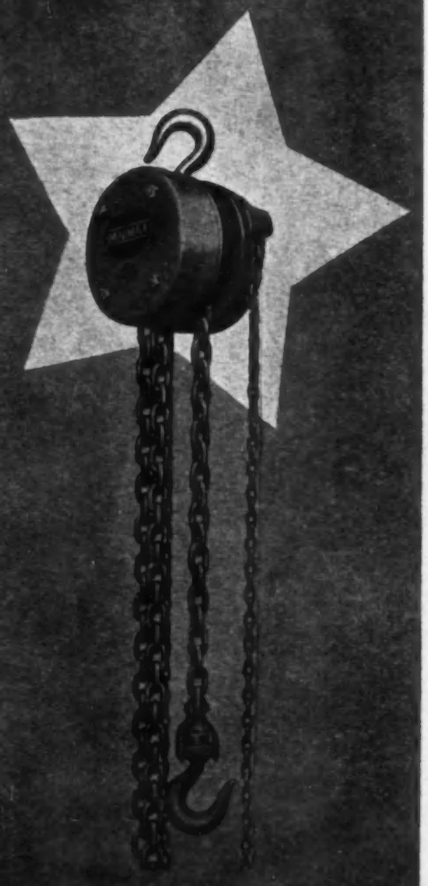

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REPRODUCIBLE FLAME FOR TESTING ELECTRICAL INSULATING MATERIALS.*

By H. L. D. WYMAN, A.M.I.E.E.

IT is desirable, in certain instances, that electrical insulating materials should be resistant to the action of a naked flame. For testing this resistance a standard flame is required which should be reproducible within reasonable limits without difficulty and at low cost. Moreover, it is desirable that users should be able to check the essential characteristics of the flame rapidly and without expensive equipment. Hitherto, it has been assumed that the Méker burner could be so used on any coal-gas supply, provided that a correction factor—based on the calorific value of the gas used—was applied to the result obtained. This correction factor was based on the assumption that the temperature of a coal-gas flame was related to the calorific value of the gas. Coal gas, however, is a complex mixture of several gases—some of widely different characteristics. Moreover, the relative proportions of these gases in any one coal-gas supply may vary (within limits) daily. Also, coal-gas supplies of the same calorific value are not necessarily of the same composition. Since the temperature of a coal-gas flame can be shown to be dependent upon the make-up of the gas, and only very generally upon calorific value, it is found that the above assumption is not good enough. This is shown by experimental evidence reported below. The logical conclusion to be drawn from this is that a fuel less subject to inherent and relative variations should be employed. This, too, has been investigated. Both hydrogen and methylated spirit flames have been investigated—the latter in some detail and with favourable results. As a result of this, it has been found that industrial methylated spirit appropriately used is capable of providing a flame complying with the above conditions. Furthermore, a simple and effective means of checking the characteristics of the flame has been developed.

Measurement of Flame Temperature.—Two methods were employed for the measurement of flame temperature, viz., a thermocouple method and an optical method. The former method involved the use of two platinum platinum-rhodium thermocouples, one being inserted in the flame and the other in melting ice. This method was employed for all tests on coal-gas flames. All other measurements of flame temperature were made by means of an optical pyrometer of the disappearing-filament type. This was used in conjunction with a 1·5-mm. diameter rhodium wire* which was inserted in the flame to provide an object upon which the pyrometer could be focused. It is to be noted, however, that both methods necessitated the insertion of an object in the flame. A certain amount of heat was therefore taken from the flames. This amount was probably different in each of the two methods but would probably be proportional to the flame temperature in any one method. For the purposes of this investigation, however, it was necessary only to determine *relative* flame temperatures. These losses were not, therefore, significant. All coal-gas flame temperatures given below are comparable with each other, as are the spirit flame temperatures.

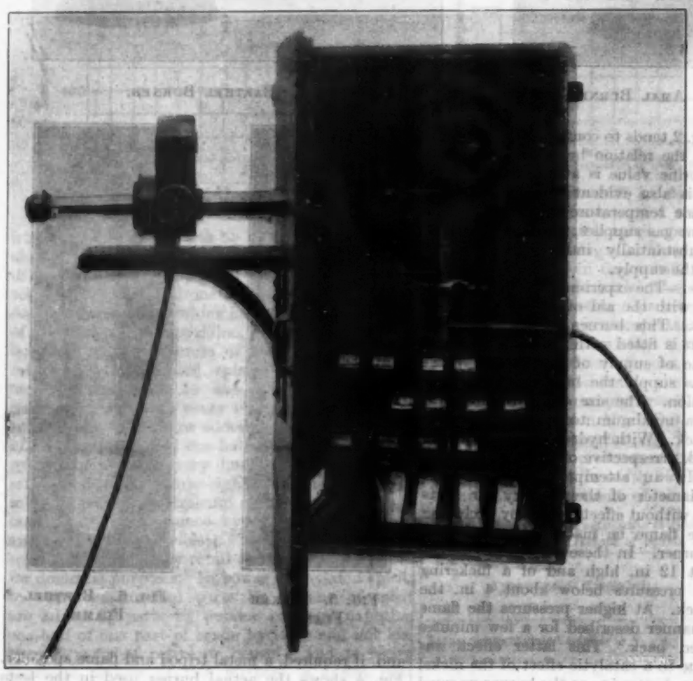


FIG. 1. CONDITIONING CHAMBER, SHOWING OPTICAL PYROMETER ON DOOR.

The effect of atmospheric humidity on the temperature of the methylated spirit flame was determined by operating the burner in a special chamber. In this, the burner was automatically provided with primary and secondary air which was conditioned by passage over the surface of a humidifying solution. The exposed surface area of the solution was increased by the use of lamp wicks suspended in the trays containing the solution. A maximum relative humidity of 91 per cent. was obtained by this means. Fig. 1 shows further details of this chamber. Unless otherwise stated, all measurements of temperature refer to a central position in the flame at a point 2 in. above the top of the burner.

Coal-Gas Flame: Factors which Determine Flame Temperature.—The utilisation of coal gas by means of the Bunsen type of burner is of long standing in the laboratory. Its use as the source of a "standard" flame in certain industrial tests is, however, a more recent introduction. Among the authorities who have specified the use of the Bunsen burner to simulate the fire hazard of a naked flame are the following:—The British Standards Institution; The Post Office Engineering Department; The India Stores Department; The Cable Makers' Association; The American Underwriters' Laboratory; and The American Institute of Electrical Engineers.

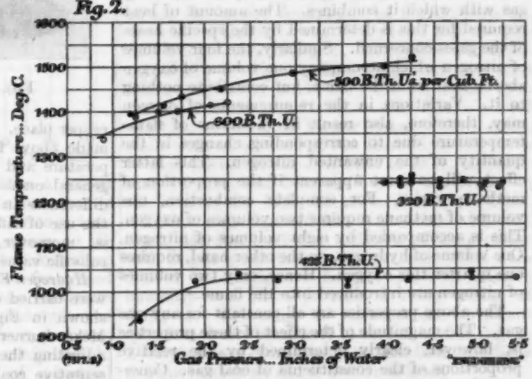
Coal gas, however, is a complex mixture of gases. On any one supply the proportions of the various gases may vary hourly and certainly from day to day. Moreover, it is very unlikely that two gas supplies of the same nominal calorific value will have the same chemical composition at any given time. Table I gives details of three typical daily coal gas analyses as furnished by a metropolitan supply. Table II gives details of the tolerance on the composition of another well-regulated supply.

Gas companies in this country are required by law to maintain the calorific value of their supplies within ± 10 B.Th.U. of the declared value. This is achieved by adjusting the proportions of the constituent gases within limits such as those given in Table II. It is the relative proportions of the constituent gases which determine flame temperature, because the various component gases each have different properties.

The following properties determine flame temperatures in the manner described:—

(i) *Density.*—This property determines the rate at which the gas issues from the jet of the burner and therefore the amount of primary air induced.

Fig. 2.



It also determines the rate at which the gas diffuses into the air at the top of the burner. Other things being equal, the more buoyant of two gases will form the longer flame.

(ii) *Rate of Flame Propagation.*—By this is meant the rate at which flame travels through an inflammable medium. If the rate is high the gas will be burned before it has proceeded far (assuming the necessary oxygen is present). Thus the rate of propagation of flame in a gas affects the volume of the flame and therefore its temperature.

TABLE I.—*Typical Daily Coal Gas Analyses.*

Constituent Gas.	Volume, per cent.		
	Analysis 1.	Analysis 2.	Analysis 3.
Carbon dioxide	2·7	2·8	3·6
Oxygen	0·7	0·7	0·9
Unsaturated hydrocarbons	3·3	3·6	3·9
Carbon monoxide	13·9	14·4	15·0
Hydrogen	49·7	50·1	47·0
Methane	22·6	21·6	21·2
Nitrogen	7·1	6·6	8·4

TABLE II.—*Typical Working Tolerance on Coal Gas Composition.*

Constituent Gas.	Minimum Content. Per cent.	Maximum Content. Per cent.
Carbon dioxide	1·5	2·0
Oxygen	0·2	0·3
Unsaturated hydrocarbons	3·3	4·0
Carbon monoxide	6·0	8·0
Hydrogen	51·0	54·0
Methane	27·3	29·0
Nitrogen	6·5	9·0

(iii) *Ignition Temperature.*—This is the minimum temperature at which two gases combine chemically. In the case of coal gas the mixture does not combine with oxygen (i.e., ignite) until the constituent gas having the lowest ignition temperature is raised to that temperature. The heat required for this is supplied by the flame.

* Being Report Ref. L/T. 75a of The British Electrical and Allied Industries Research Association, "Reproducible Flame for the Purposes of Naked Flame Tests on Solid Electrical Insulating Materials," by H. L. D. Wyman.

* Rhodium was employed for this purpose as it is the only non-oxidising metal capable of withstanding the temperature of the hydrogen flame without melting.

(iv) *Heat of Combustion.*—Being raised to its ignition temperature in the presence of oxygen an inflammable gas combines with the necessary amount of oxygen and in doing so gives off heat. This is the heat of combustion and is constant for any one gas. Of the properties here mentioned this property is the only one directly related to calorific value. If the quantity of any one constituent of coal gas varies, the heat produced by that constituent will vary proportionally. Other factors being equal, this will produce a similar variation in flame temperature. (The heat evolved by the combustion in oxygen of 1 cub. ft. of hydrogen, carbon monoxide and methane (the three main constituents of coal gas) is 341, 337·5 and 1,042 k.-cal., respectively.)

(v) *Rate of Combustion.*—This property is similar to, but of a more fundamental nature than, the rate of propagation of flame in gas. It determines, other things being equal, the volume occupied by a gas in the process of combustion.

(vi) *Specific Heat.*—The quantity of oxygen required by each constituent of coal gas depends upon its chemical composition and volume. It has to be heated to the ignition temperature of the gas with which it combines. The amount of heat required for this is determined by the specific heats of the gases concerned. Similarly, the four volumes of nitrogen which accompany one volume of oxygen absorb heat from the flame, but contribute nothing to it. Variations in the requirements of oxygen may, therefore, also result in variations of flame temperature due to corresponding changes in the quantity of the unwanted nitrogen. This latter effect will be most apparent if the proportion of methane varies. For complete combustion, one volume of methane requires two volumes of oxygen. This is accompanied by eight volumes of nitrogen. One volume of hydrogen, on the other hand, requires one quarter this oxygen. Hence, only two volumes of nitrogen are introduced into the flame.

The above properties are all constant for any one gas. The magnitude of the effect of these properties is, however, clearly determined by the relative proportions of the constituents of coal gas. Consequently, the temperature of a coal-gas flame will be affected by changes in the composition of the gas. Results given below of flame temperature observations on different gas supplies tend to confirm this.

Flame Temperature Measurements on Coal Gas Supplies.—Observations were made of the temperature of the flame produced by a 21-mm. (No. 3) Méker burner operated on four gas supplies of different calorific values. The gas supplies investigated had calorific values of 320, 425, 500 and 600 B.Th.U. per cubic foot, respectively. These supplies were in no way inter-related. Flame temperatures were determined by means of a thermo-couple (in the manner already described), the observations being made over a range of gas pressures. The latter were measured by means of a manometer. All observations were made with the burner fully aerated. Except in the case of the 500 B.Th.U. supply, the measurements were made at the works of the gas company concerned. In the case of the 320-B.Th.U. supply, the flame flashed back to the jet at pressures lower than 3·95 in. of water. Also, in the case of the 600-B.Th.U. supply, the maximum pressure available was 2·5 in. of water. In these two cases, therefore, the range of observations was necessarily limited. Fig. 2, page 321, shows the results obtained.

The gasworks giving the 600 B.Th.U. supply was not equipped with an accurate form of calorimeter. The calorific value at these works was roughly checked by observing the height of a monitoring flame supplied by the company's gas. When the tip of the flame was above an arbitrary height the calorific value was judged to be high, and *vice versa*. Since this device had been calibrated for one calorific value only, the results of such observations could not be expressed quantitatively. The fact that the flame flashed back at low pressures on two supplies suggests that the gas contained a relatively large proportion of hydrogen. A flame flashes back when the rate of flame propagation downwards exceeds the rate of supply upwards. The rate of flame propagation in hydrogen is relatively high. Hence, a correspondingly high rate of supply (*i.e.*, high pressure) is required to maintain the flame in its proper place. Fig. 2 tends to confirm the statement made above that the relation between flame temperature and calorific value is at the best a very general one. It is also evident that considerable differences in flame temperature may result from the use of different gas supplies. This latter effect is, moreover, substantially independent of the calorific value of the supply.

Hydrogen Flame.—The experiments with hydrogen were carried out with the aid of the Amal burner shown in Fig. 3. This burner is similar to the Méker burner, but is fitted with a needle valve for adjusting the rate of supply of gas. On a representative coal gas supply the burner proved very flexible in operation. The size of the flame could be varied from a maximum to zero without the flame flashing back. With hydrogen, however, the flame flashed back, irrespective of the setting of the needle valve. In an attempt to counter this tendency, the diameter of the primary air ports was reduced, but without effect. Only by excluding all air could the flame be made to burn at the mouth of the burner. In these circumstances the flame was about 12 in. high and of a flickering nature. At gas pressures below about 4 in. the flame flashed back. At higher pressures the flame burned in the manner described for a few minutes and then flashed back. This latter effect was thought to be due to a catalytic effect of the nickel grille of the burner increasing as the burner warmed up. As a result of these experiments it was concluded that the use of hydrogen would involve the development of some special type of burner. As it was not clear that the practical difficulties indicated could be overcome, it was decided not to pursue the matter until other simple solutions had been tried and failed.

Methylated Spirit Flame.—The desirability of using a fuel not subject to variation in composition now led to the consideration of the use of methylated spirit. Preliminary experiments were made in which a heated Amal burner was fed with spirit vapour. These showed considerable promise and indicated the design principles of a suitable burner. At the time these experiments were carried out the writer was unable to obtain an English burner suitable for the purpose in hand.* Consideration of the available burners led to the choice of the Barthel type "Onix" 20-mm. (size B) spirit Bunsen burner. This burner is manufactured by a German firm (G. Barthel) and is designed for use with methylated spirit. It is supplied complete with a fuel container, length of flexible metallic tubing, and, if required, a metal tripod and flame spreader. Fig. 4 shows the actual burner used in the tests reported below.

In operation, the burner is first primed by allowing spirit to burn in the open heating cup. The lower part of the burner (up to the needle valve) is packed with lengths of circular metal wire arranged axially along the burner stem. These are heated in the first place by the primary heating, and, thereafter, by conduction of heat from the flame down the thick burner stem to the wires already mentioned. These wires do not materially impede the flow of the spirit which is rapidly vaporised by the heat and the relatively large surface they offer. To facilitate the conduction of heat to the lower part of the burner the base of the flame is located about 1¼ in. below the top of the burner. This is achieved by means of a circular nickel wire mesh, which covers the section of the burner tube at this point. The fuel container has a capacity of about 1¾ pints, which is sufficient for about 5 hours operation. The flame is non-luminous, free from smoke or soot, reducing throughout most of its section and oxidising along its boundaries. In size and general appearance it is similar to the flame of the Méker burner coal gas flame, as is shown by the photographs reproduced in Figs. 5 and 6.

Effect of Fuel Composition on Flame Temperature.—The statutory rules and orders (1930, No. 832) relating to methylated spirit give details of four types, as follows :—(i) Industrial methylated spirit,

* More recent investigation has revealed that automatic spirit Bunsen burner No. W.D.C. 908, manufactured by Messrs. Baird and Tatlock, is entirely suitable for the purpose here considered, and is a satisfactory substitute for the Barthel 20-mm. burner.

FLAME FOR TESTING INSULATING MATERIALS.

Fig. 3. Amal Burner.

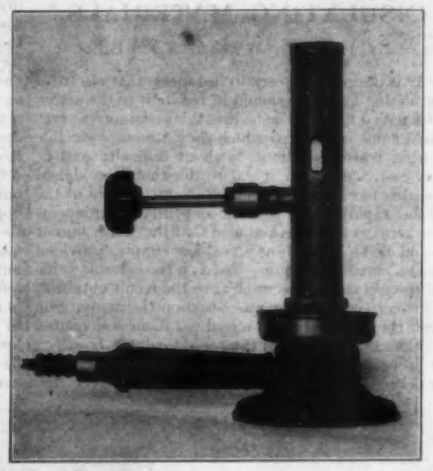


Fig. 4. Barthel Burner.

Fig. 5. Méker Flame.

Fig. 6. Barthel Flame.

FLAME FOR TESTING INSULATING MATERIALS.

Fig. 7.

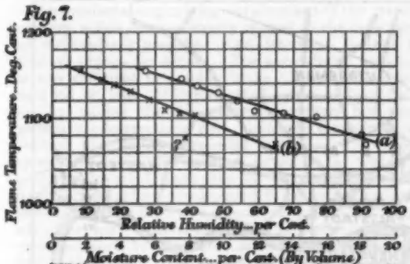


Fig. 8.

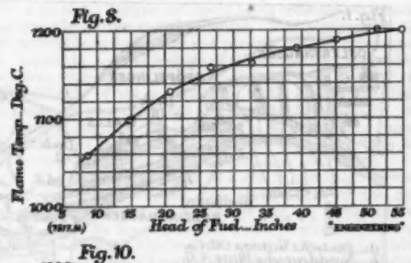


Fig. 9.

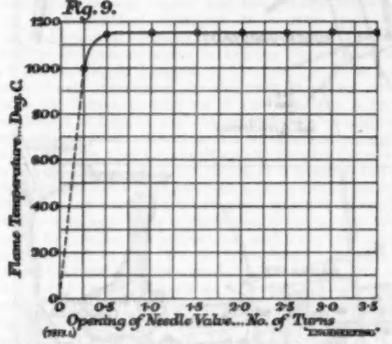
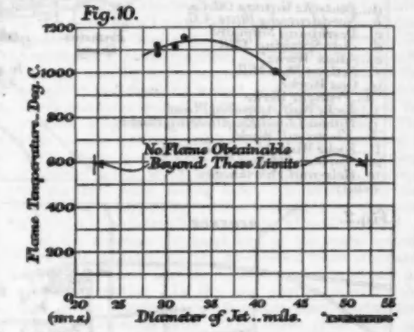


Fig. 10.



which comprises 95 parts by volume of spirit (*i.e.*, alcohol) and 5 parts by volume of wood naphtha; (ii) pyridinised industrial methylated spirit, which consists of industrial methylated spirit to every one hundred parts of which has been added one-half of one part of crude pyridine, this spirit being used largely by manufacturers of varnishes, etc.; (iii) mineralised methylated spirit; and (iv) power methylated spirit. In the case of mineralised methylated spirit, to every 90 parts by volume of spirit (*i.e.*, alcohol) are added 9½ parts by volume of wood naphtha and one-half of one part of crude pyridine; and to every hundred gallons of this mixture is added three-eighths of one gallon of mineral naphtha (petroleum oil) and not less than one-fortieth of an ounce by weight of powdered aniline dye (methyl violet). This is the methylated spirit which is sold by retail chemists and oil stores for domestic purposes. In power methylated spirit, to every one-hundred parts by volume of spirit are added 2½ parts by volume of wood naphtha, one-half of one part of crude pyridine and not less than 5 parts of petrol or benzol; and to every thousand gallons of this mixture is added one-quarter of an ounce by weight of "Spirit Red III" dye. This spirit is employed as a fuel in certain internal-combustion engines.

All methylators are required by law to employ none other than the denaturants mentioned above. It is permitted, however, that water may be present in methylated spirits provided such addition does not reduce the strength below 60 per cent. over proof.* The maximum adulteration by water in the case of good quality† industrial methylated spirit is, however, 0·4 per cent. (by volume). The poorest quality of industrial methylated spirit contains about 4 per cent. (by volume) of water. The effect of this latter on flame temperature is equivalent to the effect of 0·8 per cent. (by volume) of water vapour in the atmosphere. This, as is shown later, is negligible. Tests were made only on the more common types of methylated spirits. Neither pyridinised nor power methylated spirit was tested as they are less readily obtainable, and, therefore, less suitable for the purpose under consideration. The results are given in Table III.

In the course of these tests it was found that the dye in the mineralised spirit tended to clog both the jet and the wire packing. The dye in power methylated spirit would no doubt have a similar effect. Further tests carried out, as a matter of interest, with surgical spirit, gave an average temperature of 1,165 deg. C. Owing, however, to the castor oil present in this spirit, the jet clogged up after a short period and the burner functioned erratically. Neglecting this result, the maximum difference in flame temperature observed was 35 deg. C. Such a variation is, for most purposes, negligible. Moreover, it can be minimised in practice by standardising the use of industrial methylated spirit complying with British Standard Aircraft Specification No. 3.D.9. This was used in all subsequent observations, thus avoiding also trouble due to the presence of dye.

Effect of Relative Humidity on Flame Temperature.—The main constituent of methylated spirits is ethyl alcohol, which on combustion, gives both water and carbon dioxide ($C_2H_5OH + 3O_2 = 2CO_2 + 3H_2O$). Of these, water is also likely to be present in the atmosphere in significant amount. Variations in this amount will cause variations in flame temperature. Some difficulty was experienced in observing the effect of atmospheric humidity, because the atmosphere in the chamber (shown in Fig. 1) warmed up slowly while the burner was in operation. Furthermore, owing to the heat radiated from the burner itself it was not possible to determine the relative humidity of the air as it entered the primary air holes. These limitations would have been rendered less effective by observing flame temperature under various natural conditions of humidity. Observations were made at a point 1 in. above the base of the burner. The results obtained are shown graphically in Fig. 7, in which curve (*a*) relates to the effect of relative humidity and curve (*b*) to the effect of moisture content. The head of fuel was 32 in. to 34 in. in these experiments.

TABLE III.—*Flame Temperatures Obtained with Different Types of Spirit. Height of spirit, 30½ in. to 32½ in.*

Type of Spirit Employed.	Observed Temperature. Deg. C.
Industrial methylated spirit	1,150 1,150 1,145
Mineralised methylated spirit (British Drug Houses, Limited).	1,116 1,115 1,118
Mineralised methylated spirit (from local oil stores).	1,118 1,123 1,119
Mineralised methylated spirit (Boots, Limited)	1,135 1,140 1,140

Over the observed wide range of atmospheric moisture content, flame temperature varied by 86 deg. C. The average laboratory atmosphere however, is not subject to such extreme variations of moisture content. A relative humidity of 65 per cent. at 70 deg. F. (21·1 deg. C.) (*i.e.*, 1·5 per cent. water vapour by volume) may be taken as the normal condition of a laboratory atmosphere. Similarly, saturation at 80 deg. F., and dryness at any temperature, may be taken as extreme conditions. Such extremes would result in variations in flame temperature of −14 deg. C. and +25 deg. C., respectively, below and above the value under the "normal" condition. This total range is 39 deg. C., and for practical purposes is negligible.

Effect of Head of Fuel upon Flame Temperature.—The makers of the Barthel burner recommend that the fuel container should be suspended at a height not exceeding 3 ft. above the bench on which the burner is stood. They omit to state, however, whether this distance refers to the top or bottom of the container. The effect of actual head of fuel was determined over distances of from 8·5 in. to 54·5 in., the measurement being made to the level of the fuel in the container. In the experiments, the relative humidity was 30 per cent. and the dry-bulb temperature 33 deg. C. The results are shown graphically in Fig. 8. This graph indicates that flame temperature tends to be less dependent upon fuel head as the latter is increased. Above a head of 40 in., however, the burner became unduly noisy, while with a fuel head of less than 15 in. the flame became visibly smaller. A head of 30 in. (approximately), measured from the base of the burner to the level of the fuel, was selected as appropriate. All other tests reported here were made with that head. At this level the variation of temperature with height is less than 3 deg. per inch. If it were desired to compensate for the effect of relative humidity this effect provides a ready means of doing so. The range of variation due to atmospheric moisture is unlikely to exceed, say, 40 deg. C. A simple means of arbitrarily standardising the flame to achieve such an end is described later.

Effect of Adjustment of Burner Valve upon Flame Temperature.—The Barthel burner is fitted with a needle valve in order that fuel may be prevented from issuing from the jet during the primary heating period. This valve can be used for controlling flame temperature. It is not recommended for such purpose, however, as the burner functions satisfactorily only if it is providing a fairly substantial flame. Tests were carried out to determine the effect of adjustment of the valve on flame temperature, the head of fuel used being 33 in. to 33·5 in., the relative humidity 30 per cent., and the dry-bulb temperature 33 deg. C. The results are plotted in Fig. 9. From these results it will be seen that, provided the valve is more than one-half turn open, any further opening has no effect on flame temperature. At this point, it is evident that the jet becomes the limiting aperture.

Effect of Jet Diameter on Flame Temperature.—Earlier experiments with a typical Méker coal gas burner had demonstrated that the diameter of the jet affected the size, shape and temperature of the flame. Unlike the Méker burner, the Barthel burner is fitted with a removable jet. New jets can be obtained from the usual sources. Different jets bear different code numbers, however, and the appropriate number should be quoted when ordering. Fig. 10 indicates the effect of jet diameter on flame temperature. In these tests, the head of fuel was 34 in. to 36 in., the relative humidity 25 per cent. to 35 per cent., and the dry-bulb temperature 53 deg. C. From the curve of Fig. 10, it appears that the optimum diameter of jet is between 32 mils and 42 mils, and is appreciably nearer the former value than the latter. It is probably about 34 mils diameter. The diameter of the jet supplied with the burner employed was 31 mils. A nominal duplicate of this jet had a diameter of 32 mils. The corresponding difference in flame temperature was less than 20 deg. C., which, by itself, is negligible from the point of view of inflammability tests. However, by making a practice of cleaning out a new jet with a No. 67 (0·032 in.) drill, this effect can be minimised.

(To be continued.)

* Proof spirit is alcohol containing 49·28 per cent. real alcohol by weight or 57·10 per cent. by volume and having a specific gravity of 0·920 at 60 deg. F.

† *I.e.*, conforming to British Standard Aircraft Specification No. 3.D.9.

AIR-RAID DAMAGE IN GERMANY.

Additional particulars, now issued by the Ministry of Economic Warfare regarding the raids carried out by the Royal Air Force during December and January on industrial targets in Germany, relate to Bremen and Wilhelmshaven. Bremen is the second largest seaport in Germany and is primarily of importance for that reason. The old town is situated on the north bank of the Weser, some miles from its mouth. One group of docks is also on the north bank immediately below the old town. The other group is on the same bank, but farther downstream, in the suburb of Oslebshausen. Upstream on the north bank is the industrial suburb of Hastedt. Across the river from Bremen is the suburb of Neustadt and beyond it the aerodrome. Bremen's industrial establishments include granaries, flour mills, oil refineries, seed-crushing mills, cold stores and shipyards. Most of these are grouped around the docks and especially the Holz- und Fabrikhafen, near the town. The most important oil refinery is that of the Deutsche Vacuum Oel A.G., in Oslebshausen, which specialises in the production of lubricating oils. The Deschimag shipyard, which lies on the north bank between the two groups of docks, and which has been repeatedly bombed, is one of the most important private shipbuilding concerns in Germany, and produces every class of warship with the exception of battleships. A smaller yard, the Atlas Werke, lies almost in the main town, between the docks and the river. The positions of the main targets in this area are shown in the accompanying key plan, Fig. 1.

Of the other industries, the most important are undoubtedly the various establishments of the Focke-Wulf aircraft concern, which centre on the assembly plant at the aerodrome. There is also a smaller aircraft works belonging to the Weser Flugzeugbau G.m.b.H. In the Hastedt area, apart from one of the Focke and Wulf branch factories, are the motor works of Carl F. W. Borgwald and Hansa-Lloyd, and the municipal power station. In Oslebshausen are the coke-ovens and blast furnaces of the Norddeutsche Hütte A.G. Bremen is also an important centre for the textile industry, and possesses some important jute mills and, some way down the river, one of the largest and most modern wool-combing plants in Europe.

The damage inflicted on Bremen industries during the New Year raids fell, for the most part, on the factories and warehouses grouped around the upper series of docks. The areas which have suffered most heavily are the groups of industrial buildings and warehouses between the Franzius Quay and the River Weser, in the extreme south of the upper series of docks, and the concentration of industrial undertakings at the head of the Holz- und Fabrikhafen. In the former area, several workshops of the Atlas Werke shipyard have been demolished, damaged by high explosive or gutted by fire. While this undertaking is of no great importance as a shipyard, it is an important manufactory of specialised equipment for the German Navy. Several warehouses in this area have suffered varying degrees of damage. In the Holz- und Fabrikhafen area is an important group of flour mills, seed-crushing mills, cold stores, etc., as well as an important jute-spinning mill. Few of these undertakings have escaped damage. Navigation was also impeded in the docks by the sinking of a ship in the fairway.

In addition, several factories in the Neustadt industrial area have received damage; among them the Francke Werke, a constructional engineering firm which normally makes tanks and other apparatus for gasworks, chemical plants, oil refineries, waterworks, etc., but now, like most German engineering firms, is handling large military orders. In this area, also, the technical schools, in the Kleine Allee, were partly burnt out. Some damage was also done to the Focke Wulf aircraft assembly plant at the aerodrome.

Wilhelmshaven, a plan of which is shown in Fig. 2, herewith, is a purely naval town, with its activities centred round the naval base and dockyard. Facing south, in the well-protected Jade Bay, the series of basins, enclosed by a mole, which are in process of extension, form an important base for German light naval forces, with complete dockyard services for refitting, etc. Since the Nazis came to power, it has increased greatly in importance as a naval base and much labour has been expended on enlarging and re-equipping it. The local centre of naval activities here is the square basin almost in the middle of the town, known as the Bauhafen. This contains two large slips where the heaviest warships are built (including the new battleship Tirpitz) and several dry docks for overhaul and refitting purposes. The Bauhafen is surrounded by very important workshops—boiler shops, armour-plate shops, gun shops, etc.—which are engaged on the fitting out and repair of the vessels in the basin. The town itself contains numerous naval barracks, naval headquarters, ammunition, fuel and victualling stores.

The attacks of mid-January were concentrated on the Bauhafen area and inflicted heavy damage on the dockyard services there. It is now known that several of the most important engineering shops were destroyed or damaged, and it may be concluded that work on Germany's warships there will be subject to considerable difficulties for some time to come. The Nazis clearly think so themselves, for, shortly after these attacks, Admiral Raeder was put forward to address words of encouragement to the dockyard workers, who were exhorted to persevere in spite of difficulties and further trials ahead. Of the various dockyard buildings involved, the gun stores suffered particularly severely. A certain amount of damage was also inflicted on buildings in the town itself from "near-misses" on the Bauhafen. At the time of the raid, the British pilots observed extensive fires, which were by no means confined to the immediate area of the dockyard. It is known that several public buildings in the town were destroyed or gutted by fire, and among them important naval barrack buildings, where casualties among the personnel were heavy. In so compact an area as the Wilhelmshaven naval base, damage from a heavy attack tends to be highly concentrated and, to that extent, more severe. The full results of this attack have undoubtedly not yet been seen. They will mature slowly with the difficulties which Germany will experience in keeping her naval forces in full fighting trim, and in the delays to new construction.

AIR-RAID DAMAGE IN GERMANY.

Fig. 1.

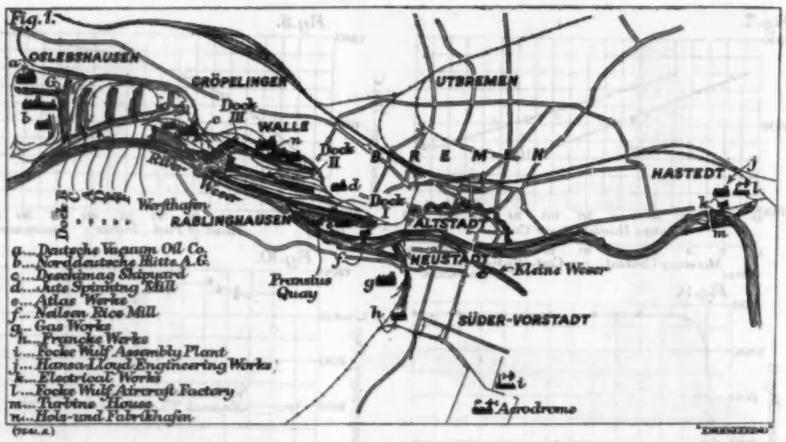
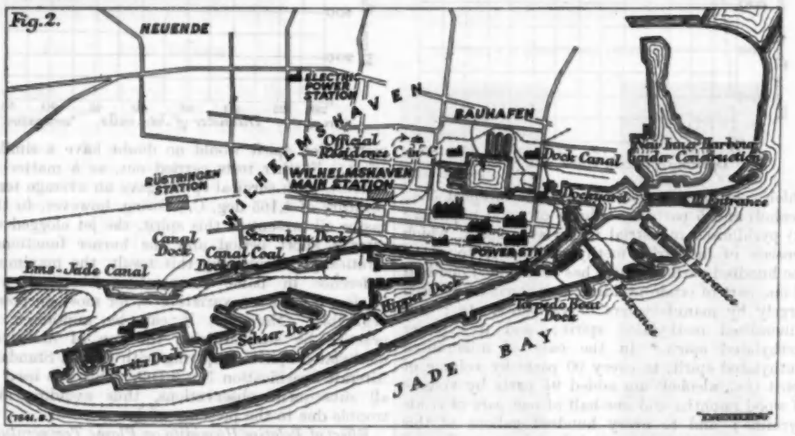


Fig. 2.



Institution of Structural Engineers.—The next examinations of the Institution of Structural Engineers will be held in the United Kingdom and at overseas centres on Wednesday, July 9, for graduateship, and on Thursday and Friday, July 10 and 11, for associate membership.

Coal Exports from India.—India is now supplying coal to many countries in the Middle and Near East. For example, the Sudan Railways recently purchased 16,000 tons and consignments totalling 20,000 tons were dispatched to Haifa, Palestine. Other orders have been received from Hong Kong, Aden and Egypt.

The Pooling of Railway Goods Wagons and Equipment.—In order to extend still further their pooling organisation for goods rolling stock, the main-line railway companies are setting up an inter-company freight rolling stock committee and central control. Prior to September, 1939, each company possessed its own organisation for the movement of goods stock, but soon after hostilities commenced a pool of certain types of special vans was introduced. Additional co-ordination is now needed to regulate the movement of other classes of goods rolling stock and equipment, and the new organisation will supervise and co-ordinate the movements, not only of vans and wagons, but also of sheets and ropes.

LABORATORY FOR TESTING BRAKE LININGS.

An incidental engineering development of the present century which can be directly related to the expansion of mechanically-propelled road transport is that of friction linings for brakes. For horse-drawn vehicles, it was sufficient to employ brake blocks made either of wood or, later, of impregnated cotton belting, built up by nailing the laminations together, but such primitive constructions were obviously inadequate to control mechanically-propelled vehicles. The rapid spread of anti-friction bearings added to the technical problems involved, each step in this direction calling for a corresponding development in brake mechanisms to deal with the increased speeds which resulted. The advances were especially notable in connection with road transport, but they have not been confined to this field; there have been similar developments in the braking of railway trains, and the greatly increased use of mechanical transport in warfare provided another powerful stimulus to improvement. With the history of these advances in braking technique, that of Messrs. Ferodo Limited, of Chapel-en-le-Frith, has been closely interwoven for the past 40 years; and, from the initial recognition of the fact that a high coefficient of friction was not necessarily accompanied by rapid abrasion, such as occurs between unlubricated metal surfaces, they have built up an extensive business, in the conduct of which the provision of research facilities on a generous scale has been a fundamental policy. The company's research department, which is equipped largely with apparatus of their own devising, has now grown to considerable proportions, and we are indebted to them and to Mr. H. H. Humphreys, managing director, for the facilities accorded to our representative, on a recent visit, to prepare the following account of the testing plant, and for the accompanying illustrations, Figs. 1 and 2, on page 326, Figs. 3 to 10, on Plate XXV, and Figs. 11 to 14, on pages 327 and 330.

Experiments with scale models have been and are still being used for research investigations, but, obviously, the conclusions drawn from such small-scale work must be based on inference. Experience has shown that, for the correct solution of friction problems, it is essential to reproduce actual working conditions as closely as possible. Clutches, brake drums, linings, etc., must themselves be tested under full-scale conditions of speed, pressure and size if reliable test results are to be assured. This research falls into two classes, namely, the finding or evolving of new materials and the determination of their fitness for a particular function. The former is mainly the work of the chemist; the latter, the subject of this article, is mainly mechanical. It is carried out in a physical testing laboratory which was built after a careful survey of the industrial field and possible future developments, and is equipped with machines to cover the whole range of industrial braking and power transmission from pedal cycles to the conditions required for braking a passenger train from the highest speeds.

The test room, which measures 75 ft. by 50 ft., is shown in the general view, Fig. 1, on page 326. A conference room, and a workshop in which test rigs can be prepared, are ranged along one side (the left, in the illustration), so that the plant is entirely self-contained. Noticeable features are the good natural and artificial lighting, and the open spacing of the machines. Fig. 2, on the same page, is a closer view of the continuous-test machine, for preliminary investigations of new materials and routine control tests of works production, with the general object of ascertaining the rate of wear and coefficient of friction at temperatures between 65 deg. and 550 deg. F., under uniform conditions approximating to those of the probable service. When the machine was made, some years ago, it was estimated that the average rubbing speed of friction linings in automobile service was about 1,000 ft. per minute. Average road speeds have since increased, but, for various reasons, the average diameter of brake drums has decreased roughly in inverse proportion.

The main spindle of the continuous-test machine carries four discs about 29 in. in diameter and driven at 130 r.p.m., one being of high-carbon steel, one of medium-carbon steel, and two of alloy cast-iron, representative of that used for brake drums. The test samples are 10 in. square, and the radial pressure is adjusted to keep the circumferential resistance at 330 lb., so that, at 1,000 ft. per minute, energy has to be converted at the uniform rate of 1 h.p. per square inch of area. The test pieces are fitted in shoes sliding on anti-friction bearings in the balanced torque arms, which can be seen in the front of each disc. The torque arm bears on the plunger of the vertical hydraulic cylinder beneath, which is connected to one of the two gauges, the gauge being calibrated to read directly the circumferential resistance at the face of the disc. Radial pressure is applied by the handwheel, through a spring buffer, on to the horizontal cylinder, which is connected to the second gauge to read applied pressure. The radial-pressure cylinders are also connected to the four recorders at the motor end, which carry charts reading over one hour, and calibrated to show the coefficient of friction; torque and speed being constant, this varies directly as the radial pressure. The plungers on the hydraulic cylinders are not packed, but are ground and lapped in, a slight leakage of oil being of less importance than unmeasured friction. It is obvious that, if the constants of the machine are to be maintained, little wear on the discs can be permitted. Actually, the normal life of a disc is measured in years. The casing round the lower half of each disc is a water bath for cooling the disc to room temperature after a run.

The standard duration of a run is one hour. Owing to the heat liberation, the temperature of the disc rises from 65 deg. to about 550 deg. F. at the end of the run. As the rate of liberation is constant (equivalent to 10 h.p.), the temperature follows a curve which is the same for all tests. This curve has been plotted against a time base and, used in conjunction with the readings of μ on the recorder, gives the frictional coefficient at varying temperatures. The durability of the sample is measured by weight and checked by micrometer measurements of thickness, to guard against the possible evaporation of a volatile constituent. The tests usually continue until about half the thickness is used. Wear is measured after each hour of running. A typical result would show wear above the average for the first hour, falling below the average for the succeeding hour, rising to the average over the next six hours, and thereafter remaining almost constant.

At the extreme left-hand end of the main spindle there is an eccentric driving mechanism which simulates the case in which friction liners are used to steady an oscillating motion. In the long stirrup, towards the back of the machine, two plates are fitted having free vertical movement only. The lower plate rests on needle rollers, and the upper one is held down by the strongback and a weighted lever. The lining to be tested is riveted on each side of a bar, attached to the eccentric, which passes through the end of the stirrup and works between the two plates. Movement of the stirrup is definitely constrained at the inner end; at the outer end it presses against a hydraulic plunger, which registers the force exerted by the stirrup in one direction, that in the opposite direction being assumed to be equal. To reduce horizontal movement of the stirrup to a minimum, the cylinder is preloaded to about 90 per cent. of the working figure. The loads on the strongback and the hydraulic cylinder give the necessary data for determining μ. This is not a routine test, but it was convenient to use this machine for the purpose.

Experience has proved the continuous-test machine to be a reliable comparator of the intrinsic qualities of the various materials. The three influential factors, namely, the rate of energy dissipation, the operating temperature and the character of the metal surface, are constant, and therefore the results vary solely in accordance with the qualities of the sample. The reproduction of working conditions for brakes or clutches is done on the inertia type of machine, of which there are two. The kinetic energy in a moving vehicle, or its inertia when stationary, can be exactly duplicated in the laboratory by using the similar property possessed by a flywheel.

The large inertia-type machine is seen in the background in Fig. 1 and in more detail in Figs. 3 and 4, on Plate XXV, and Figs. 13 and 14, on page 330, the last illustration showing clearly the method of carrying the brake slide in ball bearings. The inertia is varied by altering the number of flywheels in use, the maximum being equivalent to one wheel of an eight-wheeled railway coach weighing 40 tons. The method of torque measurement is the same as that employed on the continuous-test machine, but two torque arms are fitted, as, when running tests under wet conditions, it is necessary to take readings from both sides of the wheel. For such tests a canopy is fitted over the wheel, as shown in Fig. 13, page 330. The machine is driven by a 100-h.p. motor having a speed range of 500 r.p.m. to 1,000 r.p.m. Automatic control gear can be set to make a series of runs at intervals of 80 seconds. The electrical control is set for a speed somewhat above the test speed, and control then becomes mechanical.

On a pedestal at the right-hand end of the machine is a small direct-current motor which drives a camshaft, through suitable reduction gear, at one revolution in 80 seconds. Separate cams give the following sequence at each revolution. A relay is operated to start up the motor, and at the test speed, an adjustable centrifugal governor driven off the main spindle comes into action, operating a relay to cut off the power. The next cam opens the pressure-inlet valve to apply the brake, the rise in pressure being used also to start the timing mechanism. Finally, the test machine having stopped, the next cam opens the pressure-release valve, which also stops the timing mechanism, leaving the machine ready for the next cycle. As a safety measure, a fourth cam is fitted to break the circuit in case of failure of the centrifugal governor. The opening of the pressure-inlet valve admits pressure from the works mains to a hydraulic intensifier, situated under the pedestal. The other end of the intensifier is connected to the brake-pressure cylinders on the torque arms and also to a hydraulic accumulator, distinguishable at the right-hand end of the machine in Fig. 1. Brake pressure is measured and adjusted by means of the weights on the accumulator. Deceleration is measured by a timing gear driven by the main spindle. Two steel stylos scribe on waxed paper; one, operated by the hydraulic system, marks the point at which brake pressure was applied and released, while the other marks equal intervals of time. The chart thus gives the time for stopping, the actual distance run and, by plotting the distance between time markings, a curve of speed against time. The small $\frac{1}{3}$-h.p. motor seen in the left-hand bottom corner of Fig. 14 is used for slowly revolving the machine when cooling after a test. It drives by friction on to a keyed flywheel, and can be moved into or out of engagement on a hinged frame.

Tests on railway-type brake blocks are made by a series of runs from a specified speed, wet or dry. As in the former case, the preliminary runs to ensure proper setting of the automatic gear suffice to give a surface to the block. Weights and measurements are taken before and after the runs. The block is then reduced in thickness, and further tests are made to determine the consistency of the material throughout its depth. It is not generally necessary to keep the recording apparatus in service for the whole time, as readings at intervals are found to give all the information required. This machine can also be used for testing heavy brake or clutch assemblies of the automobile type on exactly the same principle as in the smaller machine, except that the tests proceed automatically. This part of the machine, seen to the left in Fig. 1, is connected to the main spindle through a safety shear coupling.

Fig. 11, on page 327, illustrates the smaller of these machines. Seven flywheels are fitted, one being permanently keyed to the spindle, and the remainder connected as required, giving seven steps up to a maximum inertia of 810,000 ft.-lb. at 1,500 r.p.m. The six flywheels are carried on ball bearings and when not in use are counterbalanced by the arrangement of levers seen in front, to avoid shaft deflection. The coupling of these wheels is by dowel pins near the circumference, designed so that any change between maximum and minimum can be made in about 15 minutes. The arrangements for the larger machine can be seen in Fig. 3, on Plate XXV. The single flywheel is equivalent to the front-wheel load of a medium-power motor cycle; the seven, to one wheel of a vehicle weighing 2½ tons.

The machine is driven by a motor of 25 h.p., the high power being required to give rapid acceleration between test runs. A Newton infinitely-variable hydraulic gear is interposed between the motor and the test mechanism. The speed of the motor is variable electrically between 800 r.p.m. and 1,500 r.p.m., the hydraulic gear running at 1:1. Below 800 r.p.m., variation is effected by adjusting the hydraulic gear. For test, a brake drum or clutch housing is mounted on an adaptor flange at the end of the rotary shaft, and the brake-shoe assembly on a similar flange on the torque shaft. The torque arm with its hydraulic cylinder and gauge can be seen in the illustration. When under test, the application of the brake is always made hydraulically, the power being applied by a weighted lever, at the right-hand end, which can be raised or lowered as required by the adjacent cam and handle. The effort to be applied to an operating lever is thus established, and can be simply varied when required by the test conditions. In automobile work, the relation between retardation, which is usually expressed as a percentage of g, and the brake-pedal effort is important.

On test, the machine is operated from the torque end by using a portable push-button, the electrical control being preset and automatic. The machine is started and at the specified speed the motor cuts out. The brake is then applied by dropping the operating handle, bringing the machine to rest; when the handle is lifted, the machine is ready to start up again. Several preliminary runs are made to test the correctness of the cutting-out speed and these serve to give a stable surface to both drum and lining before commencing the recorded test. A usual test is fifty stops in rapid succession at about 50 per cent. of the maximum pedal effort, with no artificial cooling. Retardation times are measured by stop watch, and readings are taken of the indicated torque. The time base is rather short for mechanically-recording these values, but experience has shown that three torque readings per run give sufficient information. Following the fifty runs, the test parts are cooled for the second test, which is a series of runs at varying pedal effort from zero to 100 per cent., to plot retardation times against pedal effort, the parts being cooled after each run. Cooling is by means of a portable fan, the machine revolving slowly meanwhile. Running the machine and taking the necessary readings requires only one operator.

TESTING LABORATORY OF MESSRS. FERODO LIMITED.

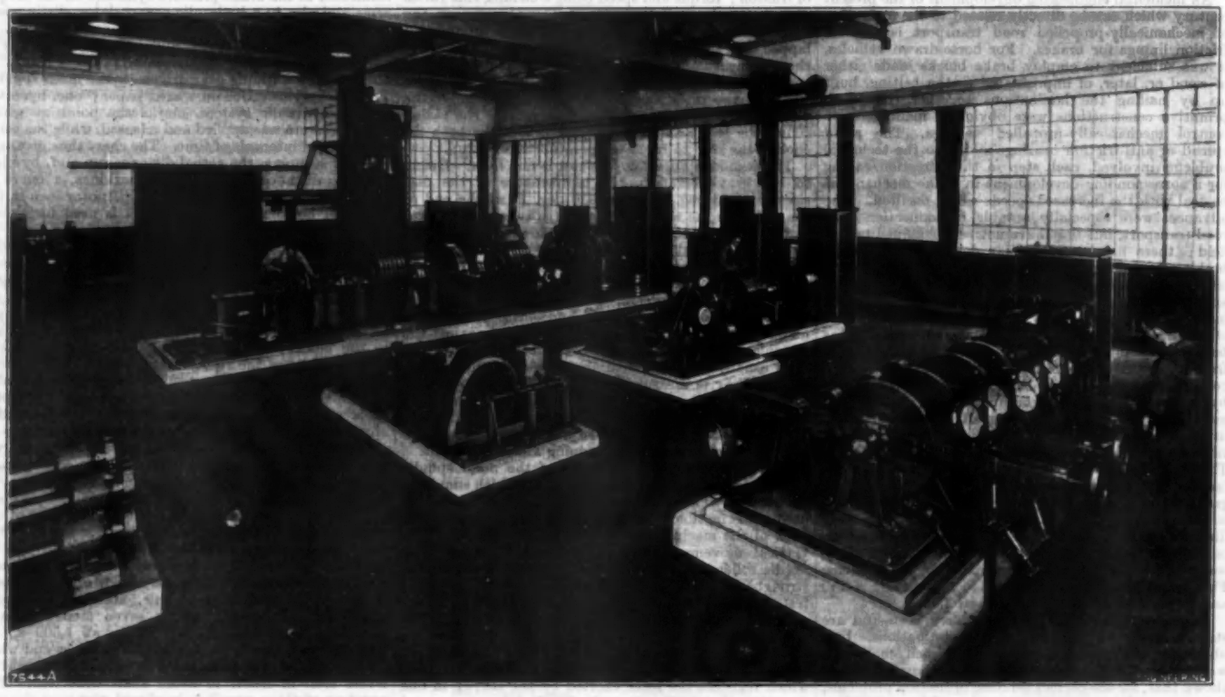


Fig. 1. General View of Laboratory.

The large vertical machine seen in the background of Fig. 14 is used for tests on heavy Vee belts, up to a belt length of 27 ft. 6 in. The routine control of works production involves measurement of the slipping characteristics and the coefficient of friction. Endurance tests are also made by running belts at an overload which has been found by experience to accelerate wear without passing into the actually destructive range. The nature of these tests calls for both high power input and long runs (say, 1,000 hours or more). It was decided therefore, to test two belts simultaneously and to absorb the power in electric generators feeding back to the line. The driving motor, of 60 h.p., with a spindle at each end, is fixed on the top platform; the generators are carried on frames, each forming one end of a steelyard, with a movable counterpoise for adjusting the belt tension. The fulcrum brackets on the main uprights can be raised or lowered independently as required by the length of the belt under test. The two steelyards can be clearly seen in the illustration, at the back of the machine. The electrical output of the generators has been calibrated over the whole range of the field regulators, as a measure of the power transmitted. The revolutions of the driving and driven pulleys are measured by hand instruments. Permanent instruments may be installed when circumstances are more favourable, but, as the time between readings is a matter of hours, it is not of great importance. The objects of these tests are to determine loss of weight, increase of length and change of section, as well as the general condition of the belt.

The smaller Vee-belt testing machine is shown in Figs. 5 to 10, on Plate XXV, and Fig. 12, opposite, and is one of the most interesting machines in the laboratory. Although of quite modest dimensions, it provides an unusually wide range of information, including measurements of the power transmitted at various belt speeds; the tension in each side of the drive, and whether it is just sufficient to transmit the load or is in a condition of excess tension; the coefficient of friction of the belt on the pulleys; the stretch, in unit time, at given duties; and the length of life, with given pulley diameters and centres. The initial object in installing this machine was to provide a test rig similar to the three-cornered drive employed on many motor-car engines for driving the fan, dynamo, etc., and to afford a means of measuring the belt forces. There are three shafts, therefore, each of which can be fitted with a suitable pulley, the lowest shaft representing the engine crankshaft and being driven by an electric motor of 28 h.p. at any desired speed between 2,250 r.p.m. and 4,500 r.p.m. The upper shaft is coupled

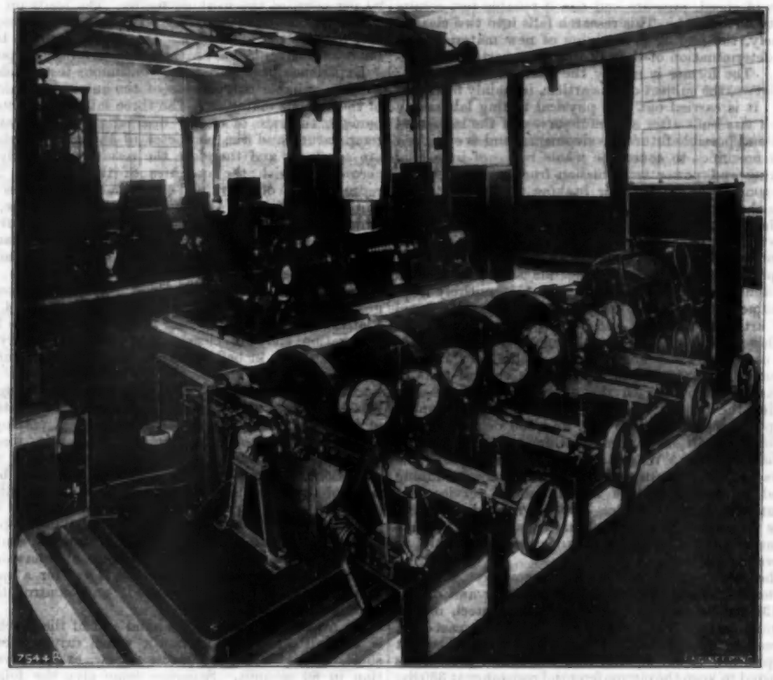


Fig. 2. Continuous Test Machine.

to a standard Heenan and Froude hydraulic dynamometer. The distance between the centres of the upper and lower shafts is adjustable, by means of the screw gear seen in front of the machine, through a range from 6 in. to 24½ in. The third shaft, representing a generator drive, is mounted on one side of the machine, and is adjustable vertically and sideways; thus it is possible to reproduce the actual pulley layout of any motor vehicle, which can be tested at any selected crankshaft speed and loading. The machine was designed and constructed by Messrs. Heenan and Froude, Limited, Worcester, in collaboration with Messrs. Ferodo Limited.

In making a test, the driving and jockey pulleys are first set at the desired centres, the driving pulley position being adjusted, as shown, by raising or lowering

TESTING LABORATORY OF MESSRS. FERODO LIMITED.

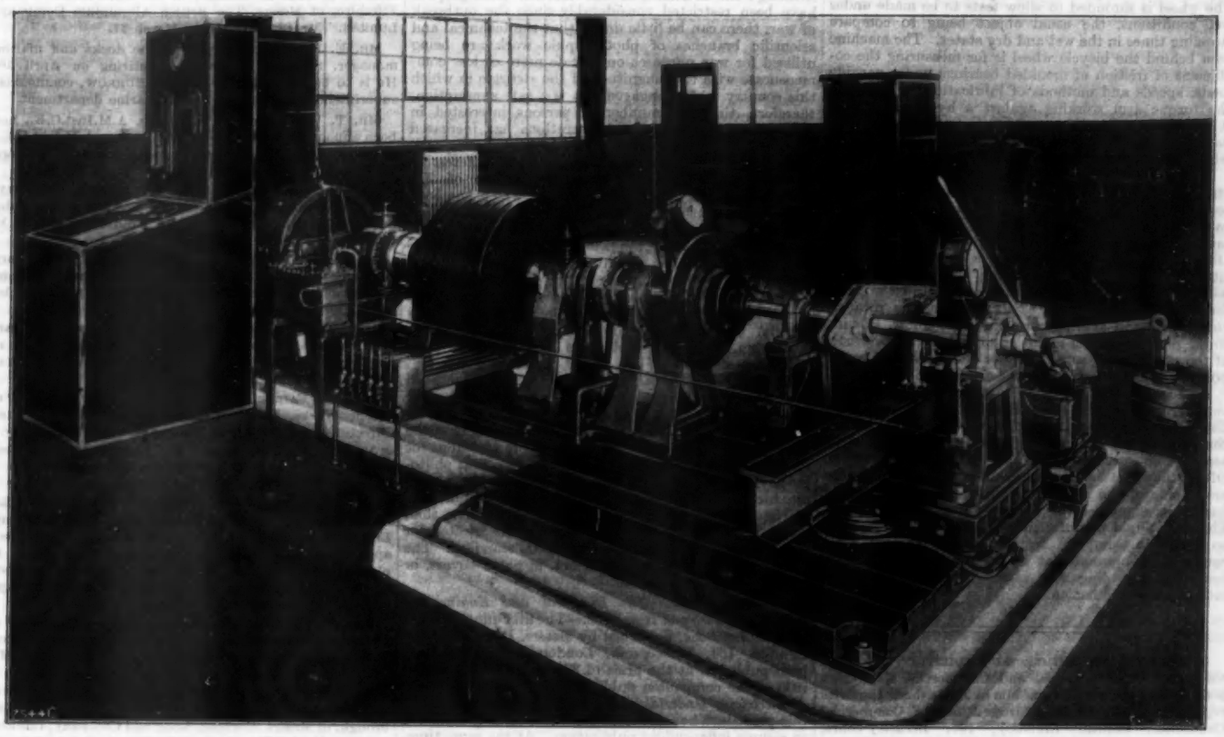


FIG. 11. SMALL INERTIA-TYPE TEST MACHINE.

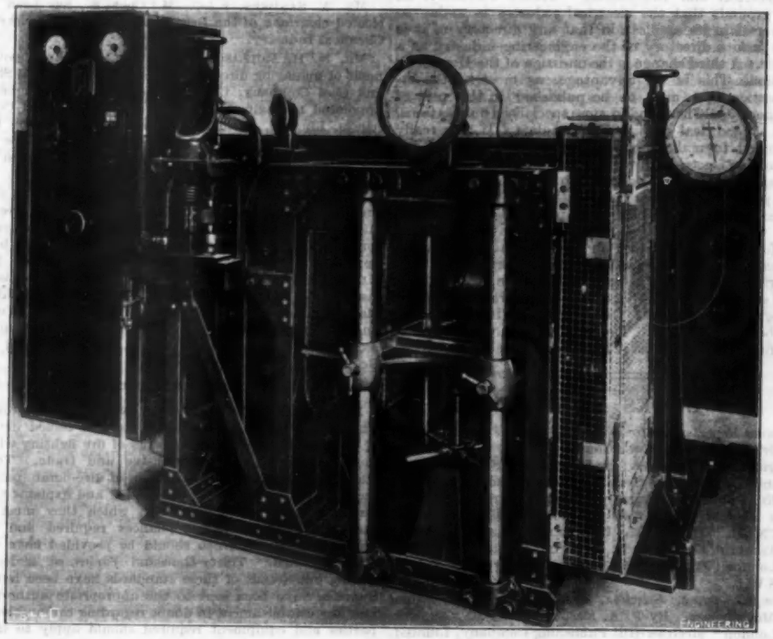


FIG. 12. SMALL VEE-BELT TESTING MACHINE.

the bearings carrying its shaft, which are mounted in a cast-iron housing, sliding on vertical guides. The jockey-pulley shaft is carried in bearings on a special adjusting head which, in addition to the horizontal and vertical movements mentioned above, can be tilted to permit measurement of the resultant force arising from the difference in belt tension on either side of the jockey pulley. The pulley-shaft bearings are mounted in a housing which is supported on a slide-bar, arranged to slide axially through a long bush attached to a worm segment. By rotating the segment by means of the handwheel and worm, the slide-bar can be set to the angle corresponding with the locus of the resultant force due to the belt tensions; this angle is automatically indicated by a special form of protractor, which is laid against the outer edges of the belt while it is stationary. Axial motion of the slide-bar in its bush is restrained by the pressure-generating unit of a Statimeter, consisting of a hydraulic pressure gauge, the dial of which is calibrated to indicate the thrust set up by the resultant of the belt forces. In prolonged tests, the slide-bar can be locked; so that the arrangement cannot be criticised as incorporating semi-flexible mountings, which might be more favourable to belt life than the actual working conditions. The horizontal adjustment of the tilting head is provided with a graduated scale to indicate the amount of stretch taking place during lengthy tests.

The bearings of the driven pulley shaft are mounted in a housing which is fitted with trunnions at one end, the other end normally being supported by a second Statimeter unit, though it can be locked in position when desired. This Statimeter thus measures the force, in a vertical direction, due to the tension in the leg of the drive between the main driving pulley and the driven pulley. As all the belt angles are known, the two sets of measurements of tensions permit the calculation, with sufficient accuracy for all practical needs, of the tension in every leg of the drive. The shaft carrying the driven pulley is coupled to a Froude dynamometer through a flexibly-jointed cardan shaft, so as not to affect the forces transmitted to the second Statimeter. The loading of the test belt is controlled by adjustment of the load-control gear of the dynamometer in conjunction with the speed of the main driving motor. This motor, which operates on direct current, is mounted on slide rails to provide the necessary adjustment of the tension in the main driving belts when the position of the lower pulley is altered.

Speed is indicated by a tachometer of the time-speed meter type, with a counter reading up to 100 million revolutions. Belt slip is measured by means of a neon-light stroboscope, the same instrument being used for all pulleys. The stand for the stroboscope is arranged so that the light shines through the wire guard on the end. Flat pulleys can be fitted when required; it is easier to determine accurately the coefficient of friction of a material by making it up as a flat belt, as this avoids the complication introduced by the shape of the Vee, which grips the sides at differing radii.

Two small machines can be seen in the centre of Fig. 1. One is for testing brake blocks for bicycle wheels. The principle is again that of the inertia machine; a plate disc is clipped to the spokes to represent the mass acting on one wheel of a machine. The drive is by a small motor, moved into position to drive by friction on the outside of the tyre, and running

the wheel up to the equivalent of 22 m.p.h. The motor is moved out of engagement, and the brake is applied by a weighted lever, as in the former case. The wheel is shrouded to allow tests to be made under wet conditions, the usual object being to compare stopping times in the wet and dry states. The machine seen behind the bicycle wheel is for measuring the coefficient of friction of moulded bearings under varying loads, speeds and methods of lubrication, again using the torque arm working against a hydraulic piston. A typical test for this machine is to investigate the varying values of μ under differing loads and speeds when water-lubricated.

In the basement of the laboratory is a small room, strongly constructed in reinforced concrete, for testing to destruction such items as clutch discs. The spindle carrying the article for test is driven by a variable-speed motor, through Vee belts, at speeds up to 9,000 r.p.m. Observation is made through a boiler-plate door, situated well out of the bursting plane and provided with two orifices, one for the observer and the other for a stroboscope which is directed at the rotating component and acts as a revolution counter. Owing to the phenomenon of retention of vision, characteristic of the stroboscope, some measure of observation is also possible of the behaviour of the article under test.

Adjacent to the testing plant is a conference room that forms a central office in which records are kept. Unlike capital expenditure on methods of production, the results of expenditure on research cannot be assessed in advance with any degree of accuracy. Often they are neither immediate nor obvious, the credit side of the account being of a nature that can hardly be expressed in figures on a balance sheet. That individual manufacturers should find it desirable to maintain complete testing plants on this scale confirms the opinion that we have expressed on many occasions regarding the value of research to both industry and the nation.

Industrial and Commercial Exhibition, Santiago de Chile.—An Industrial and Commercial Exhibition is to be held at Santiago de Chile in November. Inquiries regarding it should be addressed to the Commercial Counsellor, Chilean Embassy, 100, Berkeley-court, Glentworth-street, London, N.W.1.

Coal Mines (Cardox and Hydrox) Order, 1941.—The Secretary for Mines announces that the rules regulating the use of Cardox and Hydrox cartridges in mines under the Coal Mines Acts have been reviewed in the light of recommendations made by the Royal Commission on Safety in Coal Mines, and that the Board of Trade has made an Order under the Coal Mines Act, 1911, entitled the Coal Mines (Cardox and Hydrox) Order, 1941 (S.R. and O., 1941, No. 513, price 1d.) This simplifies and amends the rules in force under previous Orders relating to these cartridges.

Export Regulations for Electric Cables and Other Goods.—Under a Board of Trade Order which came into force on April 24, electric insulated (other than paper-insulated) wire and cable, electric cable-making machinery, and wire-drawing and wire and cable-insulating and covering machinery are among articles which may not be exported to any destination without an export licence. The Order also prohibits the exportation, without licence, of wireless receiving valves and certain mica manufactures to all destinations; and of cable, rope, cordage and twine of hard hemp, paper-insulated electric wire and cable, and insulating materials containing mica to certain specified destinations.

Distribution of Steel Supplies.—The Iron and Steel Control's booklet, *Distribution of Steel Supplies No. 3, Customers*, directed that application for steel authorisations should be addressed to the Government Department under the responsibility of which the steel was to be used. In future, however, applications from certain raw-material industries will be dealt with by the appropriate controller. In the case of manufacturers of iron, steel and ferro-alloys, application forms, for authorisations of steel for the manufacture of new plant and machinery, for the maintenance and repair of existing plant, and for the production of packages and containers to be used in processes of manufacture of iron and steel, can be obtained from the Iron and Steel Control, Ashorne-hill, Leamington Spa. Similarly, application forms for authorisations of steel for the manufacture of new plant and machinery, for the maintenance and repair of existing plant, and for the production of packages and containers to be used in processes of mining, melting, refining and manufacturing non-ferrous metals can be obtained from the Non-Ferrous Metals Control, Grand Hotel, 46, Albert-street, Rugby. Applications for steels for buildings should also be referred to the Control in the first instance, although except in cases of new buildings wholly or partly financed by the Ministry of Supply, authorisations will be issuable by the Ministry of Works and Buildings.

ANNUALS AND REFERENCE BOOKS.

The British Journal Photographic Almanac.—Although the activities of the amateur photographer have been restricted considerably since the outbreak of war, there can be little doubt that the technical and scientific branches of photographic work are being utilised for war purposes on a scale more or less commensurate with the magnitude of the struggle in which this country is now engaged. It is a safe assumption, therefore, that the number of persons interested in photographic processes and operations has increased largely during the past year. All the newcomers, and most of the older hands, will find interesting and helpful material in the 1941 edition of *The British Journal Photographic Almanac*, which has been published recently by Messrs. Henry Greenwood and Company, Limited, 24, Wellington-street, Strand, London, W.C.2. The *Almanac* is edited by Mr. Arthur J. Dalladay, who has contributed an article on "purposeful" photography, while other special articles deal with making photographic emulsions, the effect of the colour-temperature of the light source in colour photography, the copying of documents on 35-mm. film, measuring time in the dark room, and the use of pyro in modern developers. In an "Epitome of Progress," occupying some 30 pages, new photographic methods and processes are described, and new materials and apparatus for ordinary and cine photography are reviewed in another similar section. The remainder of the *Almanac* is occupied with formulæ and instructions for various photographic processes, including colour photography, exposure and other tables, notes on photographic chemicals, and miscellaneous information. The pictorial photogravure supplement is smaller than usual this year, but the examples of works selected for reproduction are quite up to the normal standard. The price of the *Almanac* is 2s. 6d. net, in paper covers, or 3s. 6d. net, bound in cloth.

The Blue Book. The Electrical and Engineering Trades Directory and Handbook.—The fifty-ninth edition of *The Blue Book*, published by Messrs. Benn Brothers, Limited, 154, Fleet-street, London, E.C.4, has just been published at the price of 25s. net. Last year the title of the companion publication, *The Annual Tables of Electricity Undertakings*, was also incorporated, but this procedure has not been repeated, as it is intended to resume independent publication. At the same time, the title has been changed from "Electrical" to "Electrical and Engineering" Trades Directory, on the grounds that the electrical industry is to-day so universal in its application that any directory of it is *ipso facto* a directory of the engineering industry as a whole. A third change is the omission of the Handbook Section. This is an advantage, as most of the information that used to be published in this part of the book could be found in more specialised publications, and a good deal of it was out of date. If it is really intended to make this work an engineering and not merely an electrical directory, the publishers might well consider rendering this omission permanent and using the pages saved to ensure that the directory portion is as complete as possible. This part, which now forms the whole of the *Blue Book*, has always been most useful, giving as it does an alphabetical list covering firms, persons and societies in the electrical and engineering industries, a geographical section, and a classified section, as well as pages containing trade names and telegraphic addresses. Quick reference is provided by tabbed guide cards. The directory should prove as useful in the future as it has been in the past.

BOOKS RECEIVED.

Annual Report of the Brisbane City Council for 1939-1940. Brisbane: Clerk of the Council.

Engineering Mechanics. By Professors S. Timoshenko and D. H. Young. Second edition. London: McGraw-Hill Publishing Company, Limited. [Price 28s.]

The Journal of the Iron and Steel Institute. Volume CXLII. Editor, K. Headlam-Morley, Secretary. Assistant Editor, A. E. Chattin, Assistant Secretary. London: Offices of the Institute, 4, Grosvenor-gardens, S.W.1.

Pumps. Types, Selection, Installation, Operation and Maintenance. By F. A. Kristal and F. A. Annett. London: McGraw-Hill Publishing Company, Limited. [Price 24s. 6d.]

Concrete Products and Cast Stone. By H. L. Childe. Seventh edition. London: Concrete Publications, Limited. [Price 8s. 6d.]

The Ohio State University. The Engineering Experiment Station. Circular No. 39. *Notes on the Properties of Clay Casting Slips.* By Professor G. A. Loomis. Columbus, Ohio, U.S.A.: The Engineering Experiment Station, The Ohio State University.

United States War Department. Port Series No. 10, (Revised 1940.) *The Ports of Savannah and Brunswick, Ga.* Washington: Superintendent of Documents. [Price 55 cents.]

PERSONAL.

Mr. S. F. Derbyshire has been appointed to succeed Mr. W. E. Sims as manager of the Burntisland Works, Fifeshire, of Messrs. The British Aluminium Company, Limited. Mr. Sims retired on March 31.

Mr. E. F. Bone, assistant to the docks and marine manager, Southern Railway, is retiring on April 30. He is to be succeeded by Mr. E. Burrow, commercial superintendent of the docks and marine department.

Mr. T. W. Brown, B.Sc. (Eng.), A.M.Inst.C.E., has been appointed to succeed Mr. W. Erdon, A.M.Inst.C.E., as district engineer, Aberdeen, London and North Eastern Railway, on the latter's retirement.

Messrs. The Associated Equipment Company, Limited, Southall, Middlesex, are opening a new sales and service depot at Canal-road, Bradford. Mr. C. F. Calvert is to be in charge.

Mr. H. Kidd has relinquished the office of honorary treasurer of the Institution of Professional Civil Servants, which he has held since 1935. He has been succeeded by Mr. I. Bowen.

Mr. James Strachan has been re-elected chairman, and Dr. H. Ainsworth Harrison, vice-chairman, of the Technical Section of the Paper Makers' Association of Great Britain.

Mr. W. Fairley, B.A., A.M.Inst.C.E., Director of Public Works, Northern Rhodesia, has been appointed Director of Public Works, Tanganyika Territory.

Mr. Raymond Evershed, K.C., chairman of the Central Price-Regulation Committee, has been made a member of the Industrial and Export Council.

Mr. F. Gurney, lately manager of the Leeds sub-office of Messrs. Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, 17, has been appointed manager of the transformer department, in place of the late Mr. G. E. Gittins. Mr. R. P. Horlock has been appointed to succeed Mr. Gurney as manager of the Leeds sub-office.

Mr. H. E. P. Beard has been elected a director of Messrs. Neepsend Steel and Tool Corporation, Limited, Neepsend, Sheffield, 3, in succession to the late Mr. W. F. W. Marshall.

Mr. T. Biddulph Smith, manager of the coke-oven plant at the Cleveland Iron and Steel Works, Middlesbrough, of Messrs. Dorman, Long and Company, Limited, has been elected President of the Cleveland Scientific and Technical Institution, Middlesbrough.

Mr. A. Sanders, F.I.C., M.I.Chem.E., has been re-elected chairman of the Bristol Section of the Society of Chemical Industry.

Mr. N. H. Rollason has relinquished the appointment of managing director of Messrs. Shelton Iron, Steel and Coal Company, Limited, Stoke-on-Trent, on being appointed managing director of the United Steel Companies, Limited, Sheffield. He retains his seat on the board of Messrs. Shelton, however, and his place as managing director of that company has been taken by his brother, Mr. M. H. Rollason.

The Minister of Works and Buildings informs us that Sir Geoffrey Whiskard, K.C.M.G., C.B., at present High Commissioner in the Commonwealth of Australia for H.M. Government in the United Kingdom, has been appointed Permanent Secretary to the Ministry. Mr. Hugh Beaver, M.Inst.C.E., who joined the Ministry last October as Priority Officer and Controller of Building Materials, has been appointed Director-General, Works and Buildings, and Mr. William Leitch, C.B., deputy secretary. The latter will act as Secretary until Sir Geoffrey Whiskard takes up duty.

Normal Minimum Fire-Prevention Standards.—The Fire-Prevention Executive has now issued details of the normal minimum standards of fire fighting which must be maintained by industry and trade. These standards deal with the number of fire-bomb parties required for various types of building and explains their duties and the equipment with which they must be furnished. The power appliances required and the quantity of water which should be provided have also been specified. Thirty-thousand copies of a leaflet setting out details of these standards have been issued. Supplies have been sent to the appropriate authorities and any establishment in doubt regarding the number of parties and equipment required should apply to these authorities. One, or preferably two, watchers should be posted so that they can see or hear the fall of every incendiary bomb and give immediate information on its location to fire-bomb parties. The latter should consist of three persons and each party should be provided with one stirrup hand pump, two buckets and one hand axe or light crow-bar. Inside the building there should be six gallons of water, in buckets or containers, and two sand bags on or near the top floor for every 8,000 sq. ft. of roof area. Outside the building there should be four sand bags for every 8,000 sq. ft. of road, yard or garden, while roof space, on certain buildings, should have bags provided on the same basis.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—While Sheffield continues to turn out a large quantity of products for the Government, every effort is being made to cater for commercial customers, whose needs are substantial. Local manufacturers are also doing their best to meet the demands of overseas customers. Sheffield Chamber of Commerce has received more inquiries from abroad. These include: From Tangier for steel goods; from Alberta for axes, spades, rakes, shovels, etc.; from Argentina for hammers, pliers, files, small vices and screw drivers; from the Dutch East Indies for cutting tools; and from Mexico for drills. A satisfactory state of affairs exists in the raw and semi-finished steel producing branches. Sheffield works continue to absorb heavy tonnages of hematite and pig iron, and no difficulty has been experienced in obtaining adequate supplies. Extensions to steelworks and engineering factories in various parts of the country are resulting in orders being received by Sheffield firms who specialise in the production of rolling mills, forges, foundry plant, and machines used in the production of tools. Orders for railway rolling stock are more numerous, and the output of ship steel, forgings, castings, and shipyard plant shows a further increase. Concerns producing all types of high-efficiency steels are operating at full capacity.

South Yorkshire Coal Trade.—Increased outputs are reported at many pits in this area, but the export trade continues to be restricted. Industrial coal is in strong demand, and many works are building up substantial stocks. Smalls and slacks are in request by many industries. The house-coal market is steady, and foundry and furnace cokes are active.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Welsh Coal Trade.—The decision that the Miners' Federation reached following discussions with the Mines Department, on the application of the Essential Work Order to the mining industry, has aroused considerable interest locally. It was understood that the coalowners and men have agreed to a guaranteed working week and wages of six days at present rates, whereas the original suggestion by the Mines Department was on the basis of five days. Under the Order, miners must be available for work and must be willing to perform such duties as may reasonably be expected of them. One clause in the Order which has given particular satisfaction locally was that giving the pit committees greater powers to deal with voluntary absenteeism. This, it was felt, would make a useful contribution towards meeting the demand for an increase in production of between 10 per cent. to 15 per cent. which Mr. D. R. Grenfell, the Secretary for Mines, called for in a broadcast appeal to the miners recently. The miners' leaders, it was stated, were to ask the Mines Department for its collaboration in the establishment of a National Board upon which the miners would be represented. This would give them a share in the control of the industry for which they have been pressing and which has been strongly criticised in local colliery circles. Conditions on the coal market have again shown very little change in the past week. There has been a sustained demand from both home and the foreign sections. In the former business, particularly for the more popular sorts, was checked by the difficulty in arranging stems and with outputs of most collieries well disposed of ahead, the tone was very firm. Eire continued to provide a steady outlet for the present productions of the dry steam grades, which were steadily maintained. Best large grades were only sparingly available for early delivery, but the sized descriptions were moving off well at firm figures. Bituminous smalls remained scarce and strong but dry smalls continued in ample supply to meet a slow request and were consequently dull. Cokes were busily engaged and patent fuel was unchanged.

The Iron and Steel Trade.—Activities in the iron and steel and allied trades were well maintained during the past week. Most works continue to be employed almost to full capacity, and operators had some difficulty in dealing with the sustained demand for the various finished products.

THE AMERICAN IRON AND STEEL INSTITUTE.—The 50th general meeting of the American Iron and Steel Institute will be held at the Waldorf-Astoria Hotel New York City, on Thursday, May 22.

BRAZILIAN IRON ORE.—A decline took place in the exports of iron ore from Brazil in 1940, as compared with 1939. During the first 11 months of last year 219,200 tons were shipped from Rio de Janeiro, against 363,656 tons in the corresponding period of 1939.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

General Situation.—Iron and steel works are busily employed, but congestion of orders has been reduced by the careful control of allocations, and the virtual elimination of the use of material for non-essential purposes. The increased importation of material from the United States has reduced delivery periods and is much appreciated by consumers. Nearly the whole of the prospective tonnage output for the present quarter has been disposed of and market transactions are almost entirely confined to the sale of commodities for pressing requirements. Supplies of raw materials and semi-finished products are ample.

Cleveland Iron Trade.—Increased activity at the foundries involves an additional consumption of pig iron, notwithstanding the very substantial use of scrap. Supplies are keeping pace with the expanding requirements, though Cleveland qualities of foundry pig are still scarce. There seems to be little likelihood of any material increase in the light intermittent make of local brands so long as regular and ample deliveries of iron from other producing centres continue to arrive in this area. The supply for most purposes is from the Midlands, but for special purposes adequate parcels of certain qualities of pig are coming to hand from Scotland and other quarters. Second-hands are obtaining control of a slightly increased tonnage, but are still unable fully to satisfy the demands of their regular customers. The fixed prices of Cleveland pig are based on No. 3 description at 128*s.*, delivered to buyers within the Tees-side zone.

Basic Iron.—The nominal figure for basic iron remains at 120*s.* 6*d.* There is none for sale, but the heavy make is sufficient to supply the requirements of the producers' own steelworks and occasionally provides a little tonnage for the small emergency stocks.

Hematite.—There is still some shortage of hematite, but the outlook is regarded as rather more favourable than has been the case for some time, as a considerable increase in the imports of American iron is expected. The control of distribution regulations are rigidly enforced and consumers are urged to continue the use of as much other iron as possible. Supplies are restricted to the essential needs of customers having priority delivery claims. Buyers are pressing for larger parcels, but the bulk of the iron available is passing into use at the consuming departments of hematite makers. Official quotations remain at the level of No. 1 grade of hematite at 138*s.* 6*d.*, delivered to North of England areas.

Foreign Ore.—Consumers of foreign ore have fairly good supplies, with the exception of descriptions needed for hematite production. Very extensive use is being made of native ironstone in place of ore from abroad.

Blast-Furnace Coke.—The present conditions are not conducive to business in blast-furnace coke. The supply is plentiful, but sellers have well-filled order books and are not desirous of making new contracts, while local users are extensively covered and are not inclined to make further purchases. Values are ruled by good medium qualities at 35*s.* 6*d.* f.o.r.

Manufactured Iron and Steel.—Re-rollers have substantial stocks of semi-finished iron and steel and are very actively employed. Manufactured-iron firms are well sold and are turning out a large tonnage. Authorised users of steel are finding it less difficult to obtain prompt delivery of several descriptions of material, but the demand for plates, sheets, light sections and bars is still urgent and the consumption of special alloy steels is steadily increasing. Among the principal market quotations are:—Soft steel billets, 12*l.* 5*s.*; hard billets, 13*l.* 12*s.* 6*d.*; joists and sections, 15*l.* 8*s.*; heavy ship plates, 16*l.* 3*s.*; and heavy rails, 14*l.* 10*s.* 6*d.*

Scrap.—Iron and steel scrap is still in exceptionally strong demand and the supply, particularly of heavy grades, still falls somewhat short of requirements.

UNITED STATE EXPORTS OF IRON AND STEEL SCRAP.—During 1940 the United States exported 2,823,088 tons of iron and steel scrap, valued at 48,350,886 dols. In 1939 the tonnage exported amounted to 3,577,427 tons, and the value to 55,810,417 dols.

THE INSTITUTION OF CHEMICAL ENGINEERS.—At the recent annual meeting of the Institution of Chemical Engineers, an account of which appeared on page 293, *ante*, the President presented the medals awarded for 1940. These included the Osborne Reynolds Medal to Mr. M. B. Donald for meritorious work for the advancement of the Institution during 1940 and the Moulton Medal to Mr. J. C. Farrant and the Junior Moulton Medal and prize of books to Mr. S. A. Gregory. The two last awards were for papers submitted during the session. The William Macnab Medal was presented to Mr. J. V. S. Glass for the best set of examination papers submitted in the 1940 associate-membership examination.

NOTICES OF MEETINGS.

IT is requested that particulars for insertion in this column shall reach the Editor not later than Tuesday morning in the week preceding the date of the meeting.

INSTITUTION OF MECHANICAL ENGINEERS.—To-day, 2 p.m., Storey's-gate, St. James's Park, Westminster, S.W.1. General Meeting. Informal Discussion on "Mechanical Mishaps," to be opened by Mr. G. E. Windeler.

INSTITUTE OF MARINE ENGINEERS.—To-day, 2.30 p.m., 83-85, The Minories, E.C.3. Annual General Meeting of the Guild of Benevolence.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—To-night, 6 p.m., The Mining Institute, Westgate-road, Newcastle-upon-Tyne, 1. "Plastic Theory: Its Application to Design," by Professor J. F. Baker and Mr. J. W. Roderick.

JUNIOR INSTITUTION OF ENGINEERS.—Saturday, April 26, 1 p.m., The Holborn Restaurant, High Holborn, W.C.1. Annual Luncheon.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.—Saturday, April 26, 2 p.m., Neville Hall, Newcastle-upon-Tyne, 1. General Meeting. "The Prevention of Gas-Ignition in the Overcut," by Mr. R. D. Bellby.

INSTITUTION OF CIVIL ENGINEERS.—Tuesday, April 29, 1.30 p.m., Great George-street, Westminster, S.W.1. The Forty-Seventh James Forrest Lecture on "The Mechanical Behaviour of Solids," by Professor E. N. da C. Andrade.

INSTITUTION OF ELECTRICAL ENGINEERS.—*North-Western Students' Section:* Tuesday, April 29, 6.30 p.m., The Engineers' Club, Albert-square, Manchester. Ordinary Meeting. "Electricity on Tap: An Examination of the Possibilities of Dispensing with the House-Service Meter," by Mr. E. Jacks.

INSTITUTE OF FUEL.—Wednesday, April 30, 2.30 p.m., The Royal Victoria Station Hotel, Sheffield. "Research and the Coking Industry," by Dr. E. W. Smith.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—Wednesday, April 30, 5 p.m., The Institution of Mechanical Engineers, Storey's-gate, St. James's Park, Westminster, S.W.1. Annual General Meeting. "Diesel Shunting Locomotives," by Mr. C. E. Fairburn.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—Production in the Scottish steel works is being maintained on a very high level and every effort is being made to meet the heavy demands of the Government. All classes of steel are included in current specifications. Shipbuilders and boiler makers are exceptionally busy. Black and galvanised sheets are in unprecedented demand and the total production is fully covered for several months to come. Steel scrap is still somewhat scarce, but there are prospects of a better supply in the near future. The following are the present quotations:—Boiler plates, 17*l.* 12*s.* 6*d.* per ton; ship plates, 16*l.* 3*s.* per ton; sections, 15*l.* 8*s.* per ton; medium plates, ¼ in. and thicker, rolled in sheet mills, 21*l.* 15*s.* per ton; black-steel sheets, No. 24 gauge, 22*l.* 15*s.* per ton; and galvanised corrugated sheets, No. 24 gauge, 26*l.* 2*s.* 6*d.* per ton, all for home delivery.

Malleable-Iron Trade.—In the West of Scotland malleable-iron trade very satisfactory conditions prevail and order books are well filled with business on Government account; general business is also good. The re-rollers of steel bars, although fairly busy, are still able to give prompt deliveries. Stocks of semies are ample for the present and the immediate future. Prices are unchanged and are as follows:—Crown bars, 15*l.* 12*s.* 6*d.* per ton; No. 3 bars, 13*l.* 12*s.* 6*d.* per ton; No. 4 bars, 13*l.* 17*s.* 6*d.* per ton; and re-rolled steel bars, 17*l.* 15*s.* per ton, all for home delivery.

Scottish Pig-Iron Trade.—There has been no change in the state of the Scottish pig-iron trade recently. Supplies of raw material are adequate and the furnaces are being kept operating at full capacity. The demand, however, is very heavy, especially for hematite and basic iron. Foundry iron is moving more freely. The following are the current market quotations:—Hematite, 6*l.* 18*s.* 6*d.* per ton, and basic iron, 6*l.* 0*s.* 6*d.* per ton, both delivered at the steel works; foundry iron, No. 1, 6*l.* 5*s.* 6*d.* per ton, and No. 3, 6*l.* 3*s.* per ton, both on trucks at makers' yards.

STANDARD STRUCTURAL STEEL SECTIONS IN CANADA.—By order of Mr. H. D. Scully, Canadian Steel Controller, the number of standard steel sections rolled for the structural-steel industry in the Dominion has been reduced from 267 to 70. The consequent elimination of frequent roll changes will result in the saving of considerable time, and production will be materially speeded up.

TESTING LABORATORY OF MESSRS. FERODO LIMITED.

(*For Description see page* 325.)

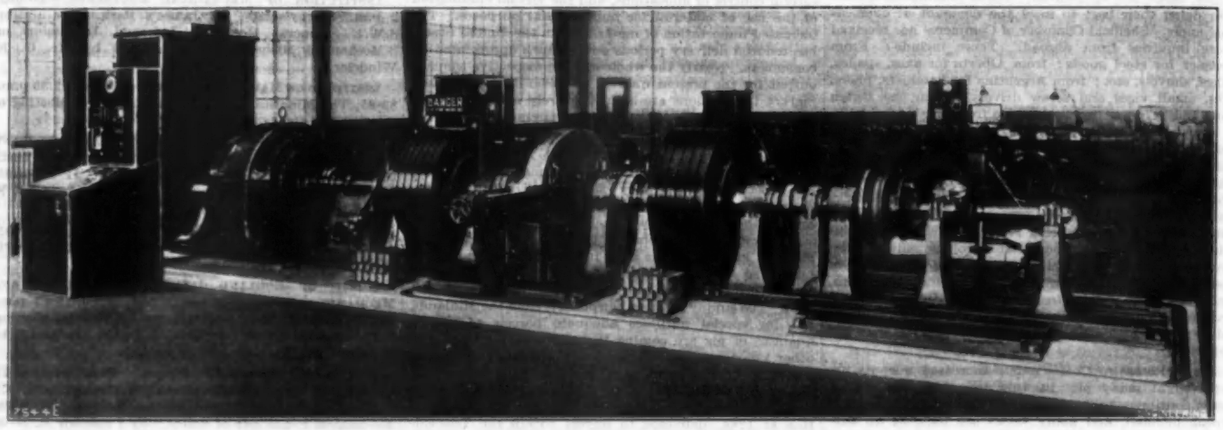


Fig. 13. Large Inertia Test Machine.

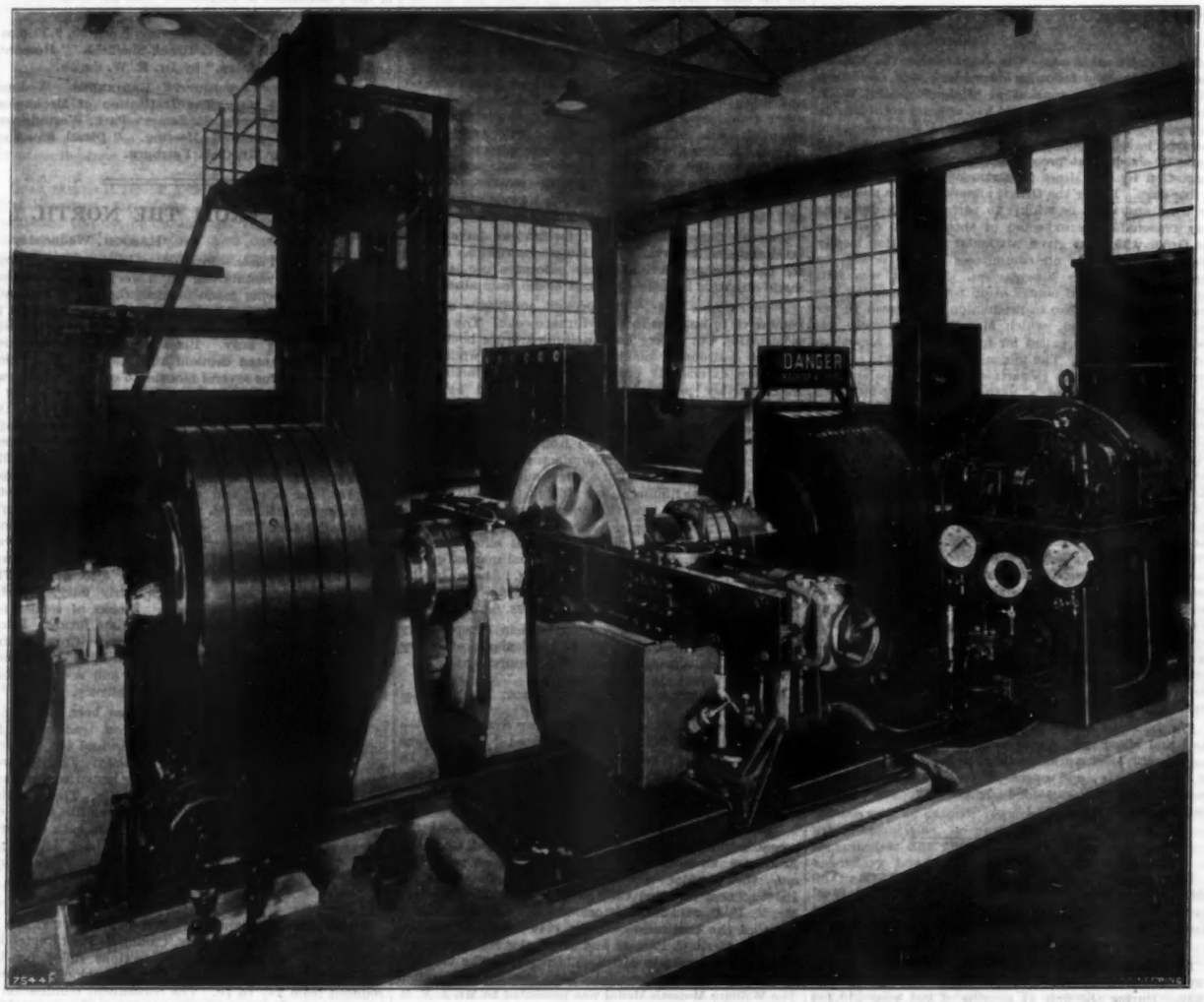


Fig. 14. Machine Testing Railway Brake Blocks.

TESTING EQUIPMENT FOR BRAKE LININGS; MESSRS. FERODO LIMITED.

(For Description, see Page 325).

Fig.3.

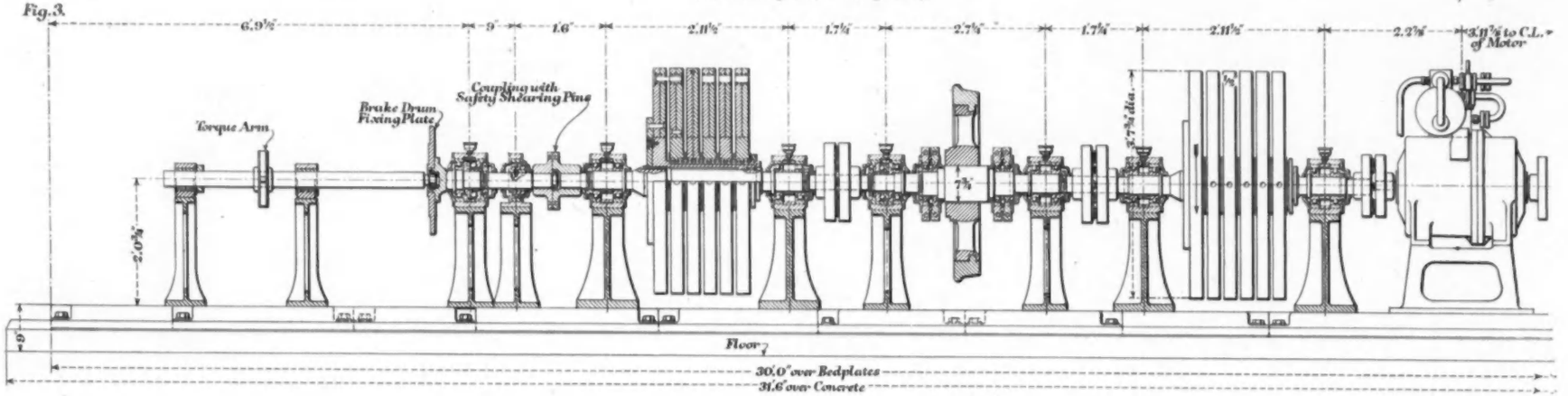


Fig.4.

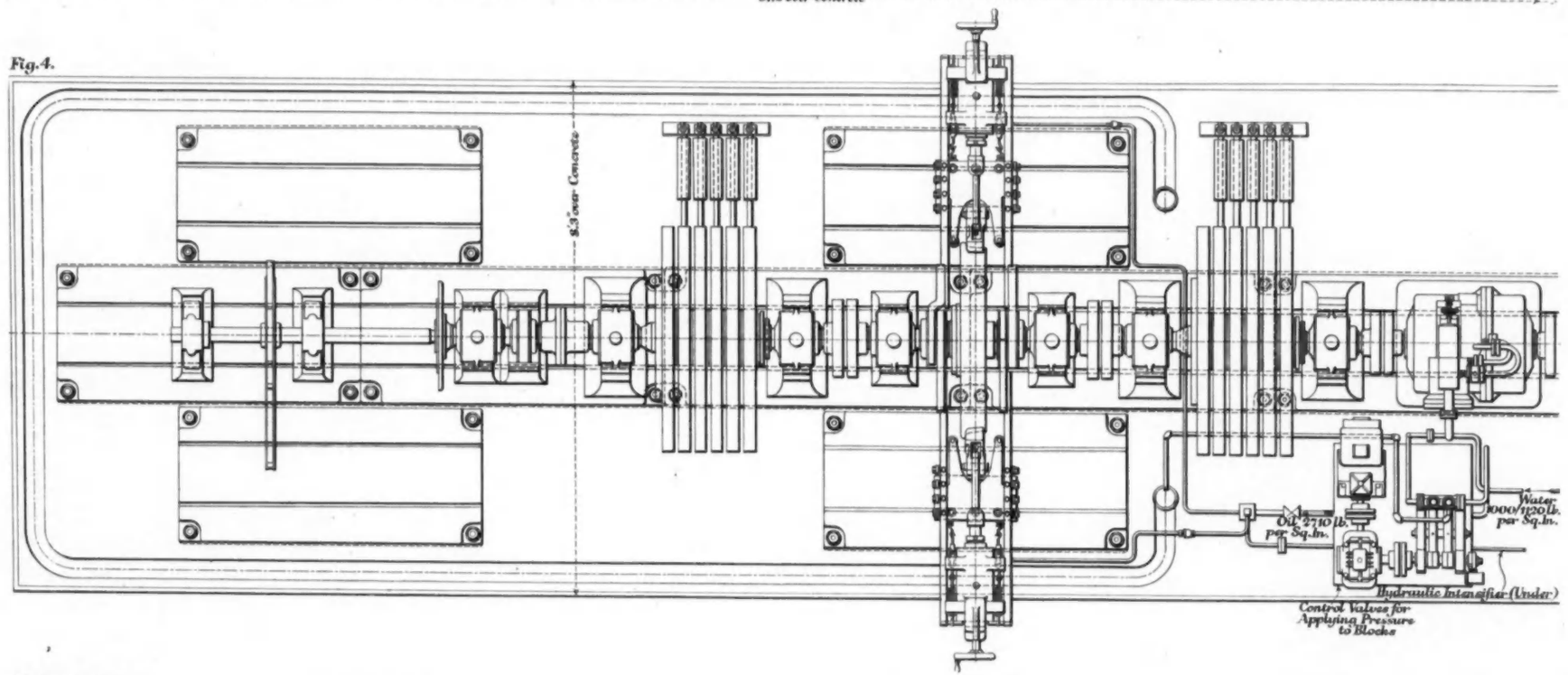
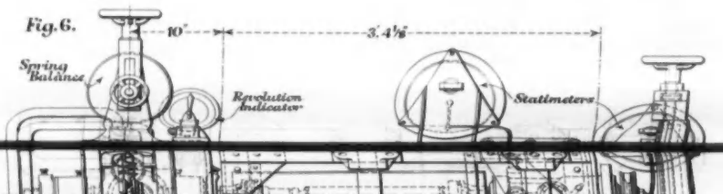
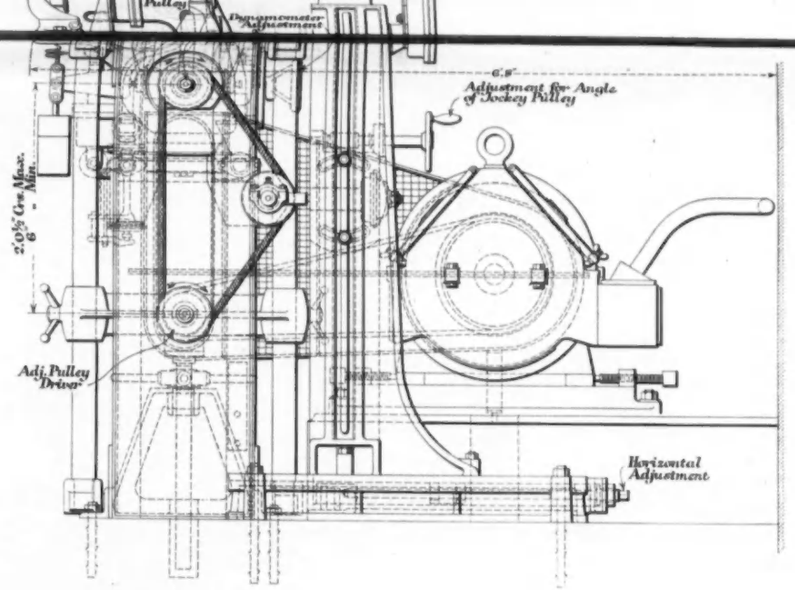

8'3" over Concrete
Oil 2,710 lb. per Sq.In.
Water 1000/1120 lb. per Sq.In.
Hydraulic Intensifier (Under)
Control Valves for Applying Pressure to Blocks

Fig.5.

Fig.6.





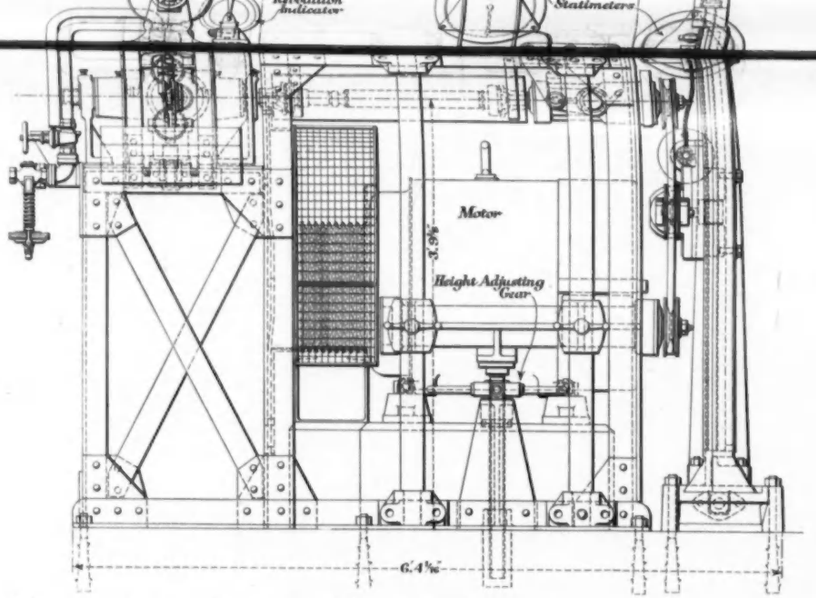


Fig.7.

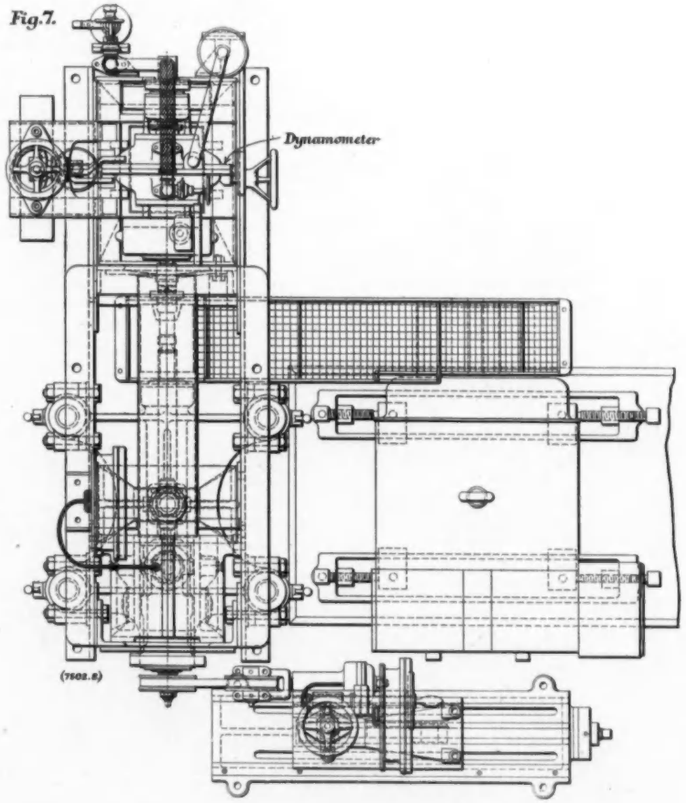


Fig.8.

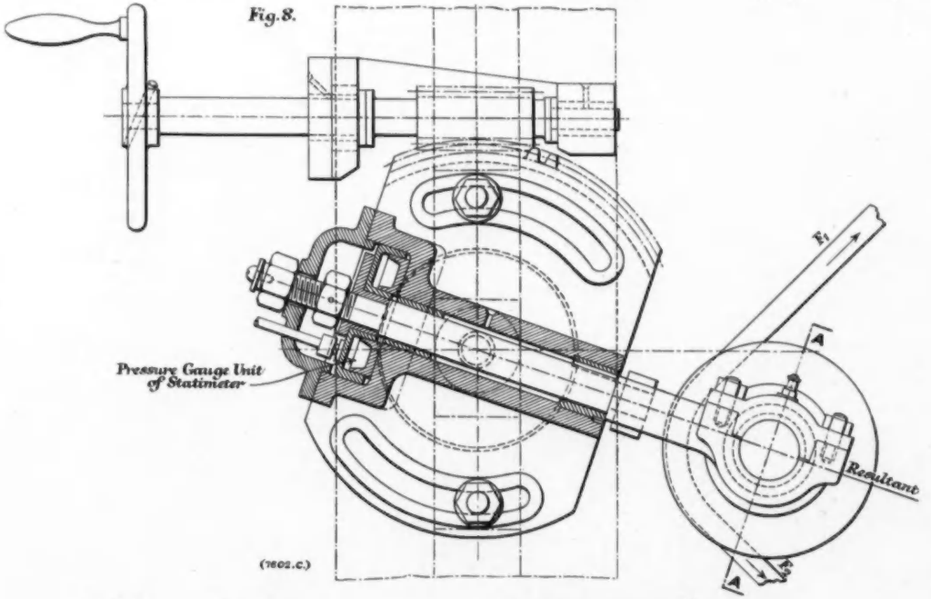


Fig.9.

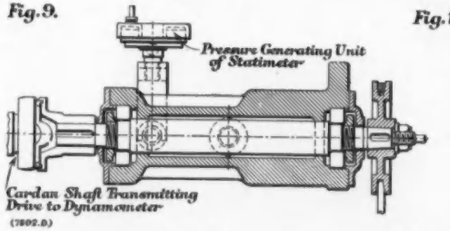
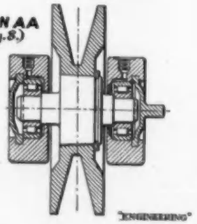


Fig.10. SECTION AA (See Fig.8.)



"ENGINEERING"

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ENGINEERING

FRIDAY, APRIL 25, 1941.

VOL. 151. No. 3928.

STANDARDISATION IN WAR-TIME.

IT has become axiomatic that the stress of war often accelerates the normal pace of technical development in many directions. Not the least significant of these, in the past half-century or so, has been industrial standardisation, a controlling influence which, indeed, probably originated in some far-off war, when the manufacture of armaments first became a distinct occupation and the warrior was no longer responsible for providing his own equipment. This was probably the first application of what may be termed deliberate standardisation on any large scale, though a certain amount of individual and almost unconscious standardisation must have existed from a much earlier date; for example, in pottery. The roughly standard sizes of the dressed stones in the Roman Wall, and the uniformity between the pigs of Roman lead that have been unearthed in different parts of this country, are more recent instances of this evolutionary standardisation, the dimensions in both cases indicating that they were dictated by questions of handling; as the items of the West African trader's or explorer's impedimenta are governed to this day, in dimensions and weight, by the load that a native porter can (or will) carry on his head.

Between this kind of standardisation for convenience and the relatively modern development of standardisation for interchangeability there are many intermediate stages; they need not be examined in detail, but their existence should be indicated, because there are still so many people who appear to regard interchangeability as the principal object of standardisation. In recent years, however, the standardising authorities of the world, who normally work in a fairly close collaboration, have been at least as concerned with standards of quality as with those of mere dimensions. Industrial standardisation, indeed, has been described as being fundamentally "a unification and simplification of the requirements of industry by agreement among all the parties concerned"; a definition which permits a very wide interpretation of the functions of a standardising authority. In the case of the British Standards Institution, full advantage has been taken in the last decade or so of this wider view of its possibilities, as can be seen by the latest lists of British Standard Specifications; and as it is a basic principal of the Institution's operations that no standardisation can be considered except in response to a specific request, endorsed by both producers and users of the article, material or process in question, it may be taken as self-evident that the education of the technical public to an appreciation of standardisation is not the least of the successful labours of the Institution during the 40 years of its existence. In this they have been consistently supported, from the outset, by the technical Press.

War, and the possible needs of war, played no part in framing the policy of the original British Engineering Standards Association; even though at that time—1901—the country had been engaged for a couple of years in a war which then seemed much more serious than it does now in retrospect. It was a war in which machinery and machine products were generally less important than horses and cattle. With the war of 1914-18, however, there came the new stimulus provided by the quantity production of munitions; and, at the request of the Air Board, a great deal of standardisation was undertaken in connection with aircraft materials. It is probably true to say, in fact, that the present organisation of the Institution's work derives directly from the experience gained in that war and in the busy years of reconstruction that followed it. Now that there has come another war, more intensively mechanical and more searching in its technical requirements than any that have gone before, it is interesting to observe how much more fully the benefits of standardisation are being sought and obtained in the effort to co-ordinate the work of the many departments, old and new, which are now concerned with the industrial life of the country. It is not possible, of course, to probe very deeply into the details of much of the special work that has been going forward on Government account, but, from information supplied to us by the British Standards Institution, it is clear that the organisation created to deal with the industrial problems of peace is contributing materially to the common effort, more especially in connection with the numerous War Emergency Specifications, outline particulars of which have been published in our columns from time to time.

The probability that the organisation set up by the Institution, which brought into personal contact the representatives of practically every branch of industry according to their mutual interests, might prove of value to Government departments in such an emergency as eventually arose, was foreseen some months before the actual outbreak of hostilities; and steps were taken, accordingly, through the medium of the Board of Trade, to offer its services, as a complete unit, to any departments likely to be interested. The response was encouraging and, in the expectation that the usual peace-time procedure might not be rapid enough for war requirements, a number of small executive committees were at once formed, representative of the several sections of the Institution's work. These committees have been given authority to restrict the usual wide consultation of industry to those interests directly affected, and to reduce the time usually allowed for comment on draft specifications, with the understanding that any British Standards issued under this expedited procedure will be reviewed immediately after the war.

A measure which has proved effective in promoting co-ordination between the various departments now working to these specifications is the presence of a representative of the British Standards Institution, by invitation, at appropriate meetings of the Materials Committee of the Central Production Executive, which represents all Government departments. As an indication of the national value of the Institution's work in this direction may be mentioned the War Emergency Specification for Tins and Cans for food products, etc. This was issued, as have been other similar specifications, with the approval of the Ministry of Supply, following the recommendations of the Economy Committees established by the Materials Committee above-mentioned, and it is estimated that the first issue saved some 40,000 tons of steel within twelve months. Following the successful introduction of

these specifications, the Institution has been entrusted with the still greater task of making recommendations to the Economy Committees in respect of tinplate containers and packaging generally, a work which already has involved the formation of more than 80 committees to deal with special aspects of the subject. Another War Emergency Specification designed to effect economies in steel consumption is one standardising bolts with heads and nuts of smaller dimensions than were provided for in the pre-war standards, which is expected to save some thousands of tons of steel annually.

An extensive undertaking which should prove of great service to industry after, as well as during, the war is the rationalisation of alloy and other special steels, which is being directed by a committee under the chairmanship of Dr. W. H. Hatfield, F.R.S. It is understood that this committee has drawn up a confidential report which includes proposals for a co-ordinated series of steels, and that such sections of it as can be published in present circumstances will be issued shortly in conjunction with War Emergency Standards covering the recommended steels.

Some other special directions in which the services of the Institution are being utilised are the issue of War Emergency Standards in connection with the Ministry of Works and Buildings—a course which, it is expected, will be extended to apply also to reconstruction work; a special series, of which about 50 have been published so far, dealing with A.R.P. work, issued at the request of the Ministry of Home Security; and, in connection with questions that have arisen concerning exemptions from the operation of the Purchase Tax—for instance, definitions laying down the dividing lines between babies', children's and adult's clothing. Various recommendations have been made, also, regarding, the scope of the Limitation of Supplies Order, and concerning such items as protective boots for miners, quarrymen and moulders.

It will be seen, therefore, that the war work of the Institution has progressed far beyond the original conceptions of its founders, and that the wider scope indicated by the change of title some years ago, when the word "Engineering" was dropped, is being fully utilised. That much of this new work will prove to have a permanent value, especially in the promotion of export trade, may be taken as assured; and, indeed, definite steps are being taken at the present time with this end in view. For some time past, in association with the British Council and the appropriate branches of industry, the Institution has been engaged in compiling a series of technical handbooks in Spanish and Turkish, designed to familiarise engineers and students in Turkey and the Spanish-speaking countries with British industrial practice and products. Simultaneously, the ordinary work of collaboration with the standardising authorities of other countries continues steadily, though to a somewhat reduced extent by comparison with the pre-war scale of operations in this direction. The importance of such liaison work, in view of the gigantic task of rehabilitating trade relations which must be faced after the war, can hardly be over-estimated. Apart from the difficulties attending international financial operations, which were already acute before the outbreak of hostilities, the restriction of supplies to overseas purchasers has greatly encouraged the tendency that was generally observable, for each country to undertake the manufacture of its own most urgent requirements. The next stage, inevitably, will be that the new industries thus established will seek to expand into other markets, so that the countries affected will not merely cease to be purchasers, but will become active competitors. Only the most careful attention to their consumer needs and the maintenance of the highest quality and uniformity of product can avail against such a loading of the dice against the resumption of former trade relations; and in collating and circulating the necessary particulars of the standards to which the exported goods must conform, and ensuring that all the desired information is available well in advance of the opportunity to use it, is likely to be found one of the best justifications for the expansion of industrial standardisation from a national to an international basis.

POST-WAR PROSPECTS FOR ENGINEERS.

As more and wider controls and restrictions are imposed upon industry, and as the tale of enemy damage in the populous areas of Britain continues, the magnitude of the ultimate task of reconstruction becomes increasingly evident. Apart from the obvious needs to switch the course of manufacture back from war production to peace production with the maximum of speed and the minimum of dislocation, there will be much to be done in restoring communications to a commercial basis and in overtaking arrears of maintenance, replacement, and the progressive modernisation, which, in normal times, is so constantly in hand that it is apt to pass unobserved. The gradual realisation of the immensity of this task has been helped by the publicity already given to the various Governmental and private steps to deal with it, commencing with the appointment of Mr. Arthur Greenwood, as Minister without Portfolio, to co-ordinate the general planning programme and continuing with that of Lord Reith as Minister of Works and Buildings, with wide powers to enlist the aid of architects, engineers and other specialists who may be able to assist in clarifying the problem as a whole and concerting plans to deal with it.

It is with no desire to minimise the importance of their work or the need for the fullest preparation to implement it without delay that we venture to question whether the extent of these preliminary investigations is not leading the public in general to underestimate the recuperative powers of British industry, provided that no undue interference prevents those powers from being exercised. The experience of the last war is hardly a sufficient guide in this respect; to take only one aspect—the development of flame-cutting and the various welding processes has placed at the disposal of industry tools of great potentialities which had scarcely begun to be used twenty years ago. The work of clearing bombed areas and replacing the demolished buildings may well extend over ten years or more, but the task of reorganising productive industry, at least to the extent of being able to undertake orders in the open market, should be accomplished even more speedily than it was last time, with the aid of the improved methods now available.

The fuller degree of mechanisation which characterises the present conflict, however, is likely to have a noticeable effect upon the future of the engineering industry, in that it has called for an expansion of plant and personnel so much greater than anything that was experienced in the last war. Much of this plant will be scrapped, no doubt, and the temporary additions to personnel disbanded, as soon as the need for them disappears; but in the case of firms which have merely expanded their previous plant, while continuing to manufacture their normal products, there will be a natural reluctance to dispose of equipment that is capable of useful work if only a sufficiency of work can be found for it. As before, too, there will certainly be a proportion of the war-time personnel who will want to continue in engineering employment, either from choice or because the work in which they were formerly engaged is no longer available. Promises have been made in general terms by Government spokesmen that those who have been compulsorily transferred to work of national importance shall be reinstated in their old occupations on the conclusion of hostilities, but this is more easily said than done, and the practical impossibility of implementing such a guarantee in every individual case must have been obvious enough, even to those who gave it. The prospects of employing such plant and personnel, therefore, when the primary object of re-establishing the engineering industry on a peace-time footing has been accomplished, will depend essentially upon the care with which the possible field has been surveyed beforehand.

An indication of the possibilities which are likely to be open to engineers and engineering manufacturers in the post-war period was given by Mr. F. Heron Rogers in his presidential address to the Institution of Chemical Engineers on April 4. Primarily, of course, his concern was with chemical plant, which, from the nature of its use, is much more susceptible to wear and obsolescence than most other types of plant used in industry; but he went beyond the mere reconditioning of existing equipment of this kind to consider whether new industries might not be established, to reduce the need to import from abroad. In effect, this appears to suggest a new phase of the "economic nationalism" which was so much in evidence during the years immediately preceding the war; but some moves of this kind would seem to be inevitable, as the widespread disorganisation of Continental industry, and the financial position of nations which have been pouring out their savings and mortgaging their future incomes in prosecuting the war will make it essential for each to produce at home as much as possible of its more urgent requirements. Imports, Mr. Rogers considered, will have to be restricted for a considerable period to the raw materials needed by home industries.

This need not mean, however, that the nation must learn to exist without many of the major commodities, hitherto imported; and Mr. Rogers proceeded to indicate a few directions in which home production might be stimulated by a proper utilisation of the engineering plant and skill already available in the country. The production of oil by synthetic processes he regarded as a development of primary importance, and with it he bracketed the need to improve the physical properties of the fuel so obtained. The application of engineering science to agriculture was no less hopeful a means of restoring the lost balance of national economics. Nitrogen fixation, and the home production of calcium carbide, and of many derivatives of coal distillation, are other directions in which much more might be done to reduce the expenditure abroad of money that could be circulated to better advantage among British industries. Dyes, glass, plastics, chemical stoneware and ferro alloys were other manufactures, mentioned by Mr. Rogers in his address, which need not be imported if sufficient encouragement and security were ensured to British firms to persevere in their production.

These suggestions resulted from the consideration given to one branch of engineering by one man. If equal attention were devoted to other branches by those best qualified to estimate their possibilities, there should be no difficulty in compiling a useful guide to the future prospects of the industry as a whole. One of the activities of the Ministry of Reconstruction, towards the end of the last war, was to examine such possibilities, although there was no immediate indication in 1916, when the Board of Trade appointed a committee "to consider the position of the engineering trade after the war," of any particular date when its findings were likely to be put to practical use. That committee, the chairman of which was Sir Clarendon Hyde, made a number of helpful recommendations dealing with essential industries, technical education, trade combinations, standardisation and other matters, the upshot of which was the creation of the Engineering Trade (New Industries) Committee, consisting of representatives of civil, mechanical, electrical and structural engineering interests. Their duty was to compile lists of articles suitable for manufacture by those with engineering trade experience or plant, which were either not made in the United Kingdom before the war but were imported, and for which there was likely to be a considerable demand after the war. The need for such lists is likely to be greater after the present war than it was in 1919. It would be a wise move, in our opinion—and one of appreciable propaganda value at the present time as indicating the confidence of the Government and industry that the war can have only one outcome—if steps were taken without delay to establish a similar organisation to examine the possibilities of directing into new channels the greatly expanded resources that will be at the disposal of the engineering industry when hostilities cease. To defer such action until the peace will be too late, in view of the many trade and other associations that must be consulted. There is no need, as yet, to consider establishing another Ministry, but the preliminaries might well be put in hand at once.

NOTES.

American Co-operation.

If any doubt still exists in this country regarding the whole-hearted determination of the United States Government, and the nation which it represents, to aid the Allies in every way possible to defeat Nazi domination, it should be dispelled by the brief but forthright speech made by the United States Ambassador, Mr. John G. Winant, at the luncheon of the American Chamber of Commerce in London, held at the Connaught Rooms on April 22. The chair was occupied by Mr. Lawrence L. Tweedy, president of the Chamber, and the company included representatives of all the American organisations now operating in this country, including the American Eagle Squadron and the American Motorised Squadron. Mr. Winant emphasised, in his opening remarks, that the Embassy's purpose was to help these organisations in every way possible, for "between us Americans in England and the free and unconquerable people of this island there is a band of sympathy and understanding, of common purpose and devotion, which will live on long after Nazi tyranny has been broken and destroyed." There were two ways, the Ambassador continued, in which the American business men in England could help, and were helping. In this mechanised world, men needed complicated tools and machines with which to fight. The war had already demonstrated the superiority, man for man, of the soldiers of freedom over the soldiers of oppression wherever there had not been an overwhelming inferiority of mechanical equipment. The business men could help to ensure that the best of American and British experience was utilised to increase and speed the construction of the tools needed to win the war in the shortest possible time. In the second place, they could assist by making their associates in America more acutely aware of the realities of the war. What America required was not propaganda, but understanding. Much could be done to help England to understand American problems, and to help America to understand the needs and the problems of those who were now giving their last full measure of devotion "that freedom may not perish from this earth."

The Work of the British Electrical and Allied Manufacturers' Association.

The Annual Report of the British Electrical and Allied Manufacturers' Association for 1940, which was presented at the annual general meeting on Thursday, April 17, is a much attenuated document. We miss particularly the useful review of the electrical manufacturing industry's activities during the period and the well-informed comments on the position of national and international trade. Such information, of course, might easily be of use to the enemy at the present time, but we hope that the data on which it would have been based is being preserved and that, in due time, our ignorance will be enlightened. This is particularly desirable since the activities of the Association have greatly increased owing to the new questions which have arisen and to war conditions. At the request of the Export Council of the Board of Trade, the Association undertook the formation of Export Groups covering the whole of the material dealt with by the sections of the Association, the object being to foster export trade and to facilitate the acquisition of raw materials. As the range of manufactures was extremely wide, two main organising committees were established, dealing with electrical machinery and electrical goods and apparatus, respectively. Each committee controls eleven export groups, dealing with particular classes of manufactures. A Purchase Tax Electrical Industry Committee was also set up to assist the Government in carrying out the provisions of the Finance (No. 2) Act, 1940, and comprises representatives of manufacturers, wholesalers, contractors, and electricity supply undertakings. Each of the organisations represented carries out its own negotiations with the Customs authorities and these negotiations are co-ordinated by the Committee. During the past year, the work of the Technical Committee has been confined to those subjects which are of immediate importance. In some matters of direct war interest, working liaison has been established with the appropriate Government departments and this collaboration has facilitated progress. The number of overseas students employed in munition works during 1940 amounted to 158. These came from almost all parts of the world not in enemy occupation. An Arc Welding Electrode Section, comprising 13 firms, was established during the year. This is a satisfactory step, since this branch of the industry is particularly important at the present time.

Basic Impulse Insulation Levels.

Ten years ago a joint Committee of the American Institute of Electrical Engineers, the Edison Electric Institute, and the National Electrical Manufacturers' Association was set up to deal with the subject of insulation co-ordination. The report of this body is published in the March issue of *Electrical Engineering* and points out that, during this period, the fundamentals of making impulse tests were investigated and standardised, while basic levels were set up and provisionally tried out. As a result, a series of basic impulse insulation levels has been agreed. The co-ordination of insulation involves three steps: the establishment of insulation levels; the specification of insulation strengths of all classes of equipment in established impulse levels; and the allocation of the insulation levels to the nominal system voltages, taking into account all the operating and environmental conditions. Basic impulse insulation levels are defined as being reference levels expressed in impulse crest voltage with a standard wave not longer than the $1{\cdot}5 \times 40$ micro-second wave. Apparatus insulation, as demonstrated by suitable tests, must be equal to or greater than the basic insulation level, and this insulation must be capable of withstanding the specified voltage whether the impulse is positive or negative. The "withstand" voltage of a test specimen under an impulse of any given wave shape, polarity and amplitude which does not cause disruptive discharge, is the crest value attained by that impulse. It is laid down that apparatus working on circuits with voltages of 1·2 kV, 2·5 kV, and 5·0 kV, shall have basic impulse levels of 30 kV, 45 kV and 60 kV, respectively, while that working on 23 kV, 34·5 kV, and 46 kV shall have basic impulse levels of 150 kV, 200 kV, and 250 kV. As, however, at the present time, some apparatus does not fully meet these levels, switch and 'bus bar insulators working at the last three voltages need not comply with the conditions until January 1, 1943. After that date, no equipment will be excepted from meeting the requirements laid down if it is represented as meeting "standard basic impulse insulation levels."

The Panama Canal.

During the year ended June 30, 1940, 5,370 ocean-going vessels paid toll to pass through the Panama Canal, according to the annual report of the Governor to the United States Secretary for War, which has been published recently. This total represented an appreciable reduction in numbers and tonnage below the 5,903 transits recorded in the previous twelve months, although the difference in the amount of cargo conveyed is much less noticeable—27,299,016 tons, as against 27,866,627 tons. In addition, there were 973 transits by small vessels, not ranked as "ocean-going," and 602 by ships of the United States and Colombian Governments, vessels seeking repairs, etc., which were not required to pay tolls. The tolls levied amounted to 21,144,675 dols., compared with 23,661,021 dols. in the previous year. The various trading activities carried on by the Canal authorities also contribute to the revenue, the net total of which, for the year, was 12,287,660 dols., as against 14,522,344 dols. for 1939. The gross capital investment, as at the beginning of the fiscal year 1940, was 543,150,445 dols., and the net investment, 508,107,922 dols.; so that the net revenue represented a return of 2·42 per cent. on the net investment as against 2·86 per cent. for the previous year. These figures do not include the operations, within the Isthmus, of the Panama Railroad Company, which yielded a net profit for the year of 2,497,073 dols. The report notes that the 25th anniversary of the opening of the Canal fell within the period under review and was celebrated on August 15, 1939, when the s.s. Ancon, of the Panama Line, re-enacted the voyage of 25 years earlier, when, as the first commercial vessel to make the transit of the Canal, she opened the waterway to commercial traffic. The most interesting section of the report, however, is that dealing with the "Third Locks" project, providing for the construction of an additional set of locks approximately parallel to, but at some distance from, the existing series at Gatun, Pedro Miguel and Miraflores, together with the necessary by-pass channels linking the new locks with the present Canal channel. The construction of the new locks was authorised by Congress in an Act which was approved on August 11, 1939, and which sanctioned the expenditure for this purpose of a sum not exceeding 277,000,000 dols. Preliminary planning, which was continued throughout the year by the staff of a special engineering division, included additional mapping and detailed investigation for the location of the locks and approach channels; and geological studies, in the course of which some 40,742 ft. of core borings were made. Other questions examined included the cost and quantity estimates for locks of various sizes and in various locations; the electrical requirements for power supplies during construction; and studies of masonry designs for different sections of lock walls. Preliminary studies of the hydraulic features were also carried out, and a programme developed for a more detailed series of hydraulic investigations. The necessary bridges and viaducts also received consideration, and a full examination was made of the work that would be entailed in altering the layout of existing roads, railway tracks, buildings and municipal services, as a result of the construction of the new locks. The War Department Civil Appropriation Act of June 24, 1940, authorised the Governor, with the approval of the Secretary for War, to enter into constructional contracts to a total cost not exceeding 99,000,000 dols., prior to July 1, 1941. The actual work of construction began on July 1, 1940, under authority of the earlier Act, previously mentioned; at 7 a.m. on that day, the dredger Cascadas started to excavate at the Pacific end of the by-pass channel leading to the site of the new Miraflores lock.

Electrical Finance at Bolton.

The old question whether it is either sound finance or equitable to devote the surpluses of municipal trading departments to the relief of the rates has come up in a new form at Bolton. In the past it has been argued that it is to the disadvantage of the undertaking to use moneys acquired by the sale of electricity from a portion of the ratepayers only for general purposes, and so cogent is that view that recent electrical legislation has limited the amounts which can be so contributed. On the other hand, a much higher percentage of ratepayers than formerly are now electricity consumers, and if there is injustice it must, therefore, be less than it used to be. At Bolton, however, the question was whether 10,000*l.* should be transferred from the surplus of the Electricity Department to reduce the capital on the A.R.P. account. The Mayor argued that it would be sound finance to clear off this expenditure as quickly as possible, so that when peace came, the problems of reconstruction could be faced with greater equanimity. A year ago, he said, the Electricity Department had estimated a loss of 963*l.*, and had made a profit of 20,532*l.*, while for a period of ten years the estimated losses had been 13,445*l.*, and the profits 173,003*l.*, a state of affairs which seems to indicate timidity. Actually, the department had balances exceeding 177,000*l.*, and could easily spare 10,000*l.* On the other hand, the chairman of the Electricity Committee pointed out that during the coming year about 45 per cent. of the cotton trade would be out of action and that the probable loss would be 35,000*l.*, reducing the balance, with the 10,000*l.* claimed, by 45,000*l.* in one year. As business men, the committee were not prepared to see their assets dwindle to this extent. Moreover, if the electricity works were damaged in an air raid, they might need all the money they possessed, and he foresaw that charges would have to be increased as the result of increasing costs. Nevertheless, the Council decided to neglect this advice and to devote 10,000*l.* to the reduction of A.R.P. expenditure.

OBITUARY.

LORD STAMP.

At any time in the past twenty-five years, the death of Lord Stamp would have been regarded as a major event, alike in financial, industrial and academic circles. That he should have died, as we greatly regret to record, by an enemy bomb during the air attack on London during the night of April 16-17, is a calamity which affects so many branches of the national life that the full scope of its influence can hardly be exaggerated. The tragedy of his end was made the more complete by the fact that the same bomb killed also Lady Stamp, and their eldest son, the Hon. Wilfrid Stamp.

Josiah Charles Stamp was born on June 21, 1880, the eldest son of Charles Stamp, of Bexley, and at the age of 16 entered the Civil Service in the Inland Revenue Department. He was transferred for a time to the Marine Department of the Board of Trade, but returned to the Inland Revenue office in 1900, where his skill in mastering complicated statistical problems speedily attracted attention. Concurrently he studied economics and political science at London University, graduating B.Sc. in 1911, with first-class honours, and being Cobden Prizeman in the following year. The degree of D.Sc. followed in 1916. His promotion was rapid, and, by 1919, when he left the Civil Service, he had become assistant secretary to the Board of Inland Revenue; but the tale of his achievements in the years immediately following his resignation from this appointment showed how wise was the decision that prompted it. His new post, that of secretary and director of Nobel Industries Limited, which most men would have regarded as a full-time occupation and which he occupied for seven years, appears in review as hardly more than a background to his many other activities of this period. Newmarch Lecturer in Statistics, member of the Senate of London University, of the Royal Commission on Income Tax, the Colwyn Committee on Taxation, the Northern Ireland Finance Arbitration Committee, and British representative on the Dawes Committee on German Currency and Finance, he still found time to write a number of authoritative books on financial and economic problems of the day, more than one of which achieved at once the status of a standard work. Among them may be mentioned *Fundamental Principles of Taxation in the Light of Modern Developments* (an Italian translation of which appeared some seven years ago) and *Wealth and Taxable Capacity*. Almost as numerous were his various reports, such as those on "Double Taxation" to the League of Nations in 1923, and "The Effect of Reparations Payments on Industry," presented to the International Chamber of Commerce in 1925.

In 1927, Nobel Industries Limited was absorbed into the group of companies since known as Imperial Chemical Industries. Stamp retained a seat on the board of the new combine, but, by this time, his financial interests had widened considerably. In 1928, he became chairman of the board of the London Midland and Scottish Railway and President of its Executive; and, in the same year, a director of the Bank of England. The prominent part that he had taken in the formulation of the Dawes Plan in 1924 made it inevitable that he should be appointed also to the committee which produced the Young Plan in 1929. Two years later, he was appointed chairman of the Royal Commission which visited Canada in that year to investigate the problems of the grain trade. In the course of this visit he travelled extensively through the Canadian wheat-growing districts and also went to the United States. His principal work in the years preceding the present war, however, was that of re-organising the London Midland and Scottish Railway to meet the severe economic conditions of the depression, and preparing for the still greater ordeal that he foresaw was to come. Eventually, as the nature of that ordeal took clearer shape, it became obvious that such exceptional qualifications could not be restricted to the furtherance of merely sectional interests, even those of such importance as the direction of a great railway or the Bank of England; and, in July, 1939, he was appointed Economic Adviser to the Government. He had been a member of the Economic Advisory Council for some years, but the new post, created for him by Mr. Neville Chamberlain, was invested with an official status which previously had been lacking, and this enabled him to give more effective guidance to the various Government departments in the organisation of their war plans. The duties for which he was appointed were completed in February of this year, but his services were still at the disposal of the Government and only a fortnight ago it was announced that he had been made a member of the new War Transport Council.

Of the many other activities of Lord Stamp, and the almost innumerable honours that were conferred upon him, it is only possible to give a brief summary. He was created first Baron Stamp of Shortlands, in the county of Kent, in 1938, having already received the C.B.E. in 1918, the K.B.E. in 1920, the G.B.E. in 1924, and the G.C.B. in 1935. Honorary degrees were conferred upon him by a large number of British and other universities, including Oxford, Cambridge, Edinburgh, Dublin,

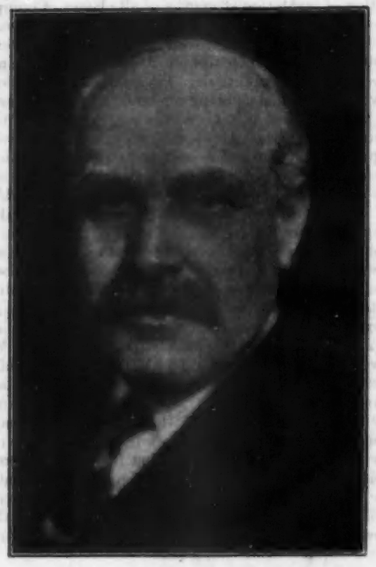


Photo: Elliott and Fry.

The Late Lord Stamp.

Toronto, Harvard, Columbia and Washington. He was made a Fellow of the British Academy in 1926. From 1930 to 1932, he was President of the Royal Statistical Society, after having been joint secretary since 1920, and was also an honorary member of the American Statistical Association and of the Hungarian Statistical Society, and a member of the International Statistical Institute; and was a member of Council of the Royal Economic Society and the Royal Eugenic Society. He was President of the Institute of Transport in 1929-30, of Section F of the British Association at their Oxford meeting in 1926, and President of the Association's Blackpool meeting in 1936. He had also been general treasurer of the British Association for a number of years, and was one of the Pilgrim Trustees; and he held the rank of colonel in the Transport and Railway Corps, Royal Engineers. His social interests were as wide as those of a more professional character, and were equally typical of the man, for to all of them he applied his great gifts with the same concentration of purpose and the same irresistible energy. If there is any consolation to be derived from the manner of his end, it is in the fact that he died in the full plenitude of his powers and was spared the realisation of their diminution which is, perhaps, one of the saddest features of advancing years.

DR. G. W. C. KAYE, F.R.S.

The news of the death of Dr. George William Clarkson Kaye, at his home at Strawberry Hill, Middlesex, on April 16, will be received with great regret by physicists and engineers in many parts of the world. Dr. Kaye who had occupied the position of Superintendent of the Physics Department at the National Physical Laboratory, Teddington, since 1922, was the son of the late Mr. George Kaye, an architect by profession, and was born on April 8, 1880. He was educated at the Royal College of Science and at Trinity College, Cambridge, where he graduated, subsequently receiving the M.A. degree. He was also a Doctor of Science of London University and a Fellow of the Institute of Physics. It was while he was engaged on research work at the Cavendish Laboratory, Cambridge, that he became acquainted with Dr. T. H. Laby, who afterwards became Professor of Natural Philosophy in the University of Melbourne. The two young scientists agreed to collaborate in the collection of the more reliable and recent determinations of important physical and chemical constants, and, in October, 1911, the first edition of their well known *Tables of Physical and Chemical Constants and Some Mathematical Functions* was published. Several editions of the work, which is familiarly known as "Kaye and Laby" among the scientific fraternity, have since been issued.

As an officer in the Royal Engineers (T.F.), Dr. Kaye, who had attained the rank of Captain in 1910, was mobilised at the outbreak of the war of 1914-18. He was afterwards transferred to the Royal Air Force, in which he became a major in 1917. He was twice mentioned in dispatches and from 1917 until 1920 served as Chief Inspector of Materials at the Air Ministry. For his services he was created an O.B.E., and received the Territorial Officers' Decoration in 1919. After the war, Dr. Kaye joined the staff of the National Physical Laboratory. At this period of his career, he was engaged on research on X-rays and was President of the Röntgen Society from 1917-18. He was also appointed honorary editor of the *British Journal of Radiology* in 1919, which position he continued to occupy until 1932. From 1935 until his death he was honorary editor of *Radiography*. In March, 1921, he delivered three Cantor Lectures before the Royal Society of Arts on "X-Rays and their Industrial Applications." Moreover, he was British delegate to the International Congress of Radiology in 1925, 1928, 1931, 1934 and 1937, acting as chairman in 1931. He was elected President of the British Institute of Radiology in 1928, holding office for two years, and at the time of his death was serving as President of the Society of Radiographers.

For some years Dr. Kaye had taken great interest in acoustics and the suppression or reduction of noise. He was chairman of the Noise Investigation Committee of the Ministry of Transport and of the Acoustics and Noise Committee of the British Standards Institution. As President of Section A (Mathematical and Physical Sciences) of the British Association meeting at Nottingham in 1937, he devoted his presidential address, entitled "Noise and the Nation," to a masterly review of the methods used in the measurement and analysis of sound in general and noise in particular. Dr. Kaye had also dealt with the subject of noise at previous meetings of the British Association; for example, he contributed an able paper entitled "The Suppression of Noise" to the proceedings of Section G at the meeting at York in 1932. In this he included a description of the new Acoustics Building at the National Physical Laboratory. Among his most recent contributions to the subject was a paper on "The Noise of Motor Vehicles," written in collaboration with Mr. R. S. Dadson, and presented before the Institution of Automobile Engineers on April 4, 1939. Dr. Kaye was elected a Fellow of the Royal Society in 1939, and at the time of his death was acting as visitor and manager of the Royal Institution, having previously served in that capacity from 1929 until 1935. In addition to the *Tables of Physical and Chemical Constants*, already mentioned, Dr. Kaye was the author of publications entitled *X-Rays* and *High Vacua*. He was also joint author of *The Acoustics of Buildings*.

THE ENGINEERING OUTLOOK.

X.—CONSTRUCTIONAL AND GENERAL ENGINEERING.

MOST constructional engineers and public works contractors were extremely busy during 1940 on Government contracts, though, in the case of those firms whose normal activities also embraced private dwelling-house construction, this increase in activity was largely offset by the almost complete cessation of house building. There was, of course, a decline in civil engineering work abroad as a result of the war, though progress continued on a certain amount of work in the Empire; for instance, in India and in those European countries not over-run by Germany. As an example of the latter, Messrs. Henry Boot and Son were engaged on an important scheme of irrigation and land reclamation in Greece. On the outbreak of war, the Greek Government instructed the firm to stop this work, but representations were made that this would be a serious disadvantage to the country, and the company was therefore allowed to continue.

Another field in which a substantial decline in activity occurred was in road building, though this decline was mitigated by the high level of repair work occasioned by the severe frost of the winter of 1939-40, while in certain parts of the country new roads were under construction for strategic reasons. In June, 1940, it was stated that the Ministry of Transport had arranged for all major road schemes to be stopped unless of pressing national importance, in order to save raw materials and man power. On the other hand, certain preparatory work on important trunk road schemes to be put in hand after the war is continuing, and the Essex County Council were authorised in March to proceed with work on the removal of a number of level crossings on the Epping branch of the London and North Eastern Railway.

The employment statistics given in the accompanying Table I, however, show that the very

TABLE I.—*Numbers Employed in Constructional Engineering: United Kingdom.*

——	Insured.	Unemployed.	Employed.
July, 1928 ..	27,290	2,146	25,144
,, 1929 ..	28,240	2,287	25,953
,, 1930 ..	27,970	4,889	23,081
,, 1931 ..	29,580	7,108	22,472
,, 1932 ..	29,300	10,102	19,198
,, 1933 ..	29,200	10,002	19,198
,, 1934 ..	31,650	6,905	24,747
,, 1935 ..	33,410	5,736	27,674
,, 1936 ..	36,120	4,387	31,733
,, 1937 ..	40,060	4,035	36,025
,, 1938 ..	46,720	5,200	41,520
,, 1939 ..	49,430	2,719	46,711
,, 1940 ..	—	1,409	—

large increase in Government contracts more than offset for the industry as a whole the decline in other work. Although figures for the number of insured workpeople are not available for 1940, there is no reason to suppose that any decline took place, and the number unemployed fell from 2,719 at July, 1939, to 1,409 in July, 1940. There were also sharp declines in unemployment over this period in both the building and public works industries, in the former case from 119,033 to 58,829, and in the latter from 102,845 to 42,373.

The shortage of steel and timber for the erection of dwelling-houses and other buildings not immediately connected with the war effort has led to a number of experiments in the use of alternative materials. In particular, the use of concrete for house building has been encouraged and an exhibition was held in Glasgow in the autumn to demonstrate the suitability of this material. The exhibition showed concrete used in place of wood or bricks in house walls, floors, stairways, roofs and even rafters. It was claimed that for many of these purposes the use of concrete was a progressive step, as concrete was a stronger, more lasting and safer structural material. Activity in the general engineering industry also increased considerably during 1940, mainly on account of the growth in direct Government work or in sub-contracts from the main armament firms. Unemployment in the industry fell from 22,443 at July, 1939, to 11,885 at July, 1940. Comparative statistics of employment in the industry are shown in Table II, herewith.

TABLE II.—*Numbers Employed in General Engineering.*

——	Insured.	Unemployed.	Employed.
July, 1928 ..	581,180	56,678	524,502
,, 1929 ..	586,750	53,002	553,748
,, 1930 ..	592,250	99,039	493,211
,, 1931 ..	576,380	167,874	408,506
,, 1932 ..	551,200	166,199	385,001
,, 1933 ..	528,190	129,742	398,448
,, 1934 ..	522,620	75,643	446,977
,, 1935 ..	527,420	65,793	461,627
,, 1936 ..	539,720	35,149	524,571
,, 1937 ..	613,910	30,175	583,735
,, 1938 ..	640,490	47,577	592,913
,, 1939 ..	661,650	22,443	639,207
,, 1940 ..	—	11,885	—

Since the first article in this series was written, the decision of the National Arbitration Tribunal on the subject of wage increases has been announced. The Tribunal awarded an increase of 3*s.* 6*d.* per week in the national bonus, to take effect from the beginning of the first full pay period following the date of the award, namely, January 20, 1941. This was to apply to the Amalgamated Engineering Union and the National Union of Foundrymen, which had claimed an increase of 3*d.* an hour and the restoration of the pre-June, 1931, working conditions; the Engineering Joint Trades movement, whose claim was for an increase of 10*s.* a week of 47 hours; and the Confederation of Shipbuilding and Engineering Unions, which also claimed an increase of 10*s.* a week. The estimated costs to the industries concerned was 9,000,000*l.*

THE PHYSICAL CONDITION OF THE PLANETS.

IN the course of a lecture which he delivered before the Royal Institution on March 25, Sir James Jeans said that with the recent development of larger telescopes astronomical interest had tended to be concentrated on the exploration of ever more distant nebulæ; but it must not be thought that this was the only field in which astronomical knowledge was growing; recent researches had also enlarged existing knowledge of the solar system. The most important factor in the physical condition of a planet was its temperature, which was largely, but not wholly, controlled by its distance from the sun. The Earth and moon were at approximately the same distance from the sun, but the noon temperature of the moon's surface was in the neighbourhood of 100 deg. C. Observations made by Pettit during an eclipse in 1940 showed that this temperature fell to — 73 deg. C. at the beginning of totality and to — 117 deg. C. at the end of totality 4¾ hours later. The Earth's much smaller temperature range was due to two factors: the store of heat retained in its crust and the blanketing effect of the atmosphere. By contrast, the moon's crust consisted of lava, pumice and other volcanic materials which possessed a low conductivity, so that its store of heat could be released only slowly. Moreover, the moon had practically no atmosphere, since its mass was insufficient to exert the gravitational pull necessary to overcome the tendency of swiftly moving molecules of gas to fly off into space. To escape from the Earth's gravitational pull a molecule must reach a speed of 7 miles per second; but the average speed of the molecules composing the Earth's atmosphere was only ½ mile per second. Thus, although at the outer layers of the atmosphere some molecules, chiefly of hydrogen and helium, could reach the limiting velocity of 7 miles per second and escape, on the whole, the Earth's atmosphere was securely retained. On the moon, however, the speed at which molecules could escape was only about 1½ miles per second, and consequently, in the course of time, all gases lighter than argon must have been lost to the moon, which now retained no oxygen, nitrogen or water vapour, and therefore no atmosphere as we knew it.

The planets did not emit light of their own and could therefore only be studied by the light they received from the sun and reflected back to the observer on the Earth. Analysis of this light gave us information in two ways. As the light passed through any atmosphere the planet might possess before being re-emitted, different wavelengths were absorbed by different gases and absorption bands were produced in the spectrum. These gave us information about the constitution of the planet's atmosphere, if it had any. Secondly, light was reflected and polarised to differing degrees in different parts of the spectrum according to the material composing the surface from which it was reflected. It was thus possible to draw some conclusions on the nature of the solid surface of a planet, if it were not obscured by cloud. The moon, Mercury and Mars had either no atmosphere or a cloudless one, and the light reflected from their surfaces had been found by Lyot to agree in its degree of reflection and polarisation throughout the spectrum with that reflected from pumice or lava. It was therefore concluded that the surfaces of these bodies were composed of such materials. The other planets had atmospheres so opaque with cloud that nothing could be learned about the solid surfaces by observation.

Passing on to consider the planets in order according to their distance from the sun, Sir James remarked that Mercury, the planet nearest to the sun, was also the hottest and was so stabilised in its rotation that it always presented the same face to the sun. In the region where the sun was overhead the temperature of the surface was found to be 343 deg. C., at which temperature tin and lead would be molten. Its size made it improbable that Mercury could retain much atmosphere. In its present condition oxygen would be retained, but no water vapour or any gas lighter than oxygen. Apart from permanent surface markings, the only observed phenomena were faint blurrings of parts of the surface which appeared from time to time; these were first seen 50 years ago by Schiaparelli and had been recently confirmed by Antoniadi. They might be explained, very probably, as dust clouds resulting from vast collapses of rock; but if this were the explanation there must be some atmosphere to sustain them, although its nature had not been discovered.

Venus, the next planet in order, was the Earth's twin sister, but was not an identical twin; the Earth had 3 per cent. greater diameter and 23 per cent. greater mass. In theory, then, Venus should be capable of retaining an atmosphere of similar quality to that of the Earth, but observation revealed that the actual case was very different. The Earth, as seen by an observer on Venus, would show an atmosphere containing much ever-changing cloud, but through gaps in the clouds the permanent surface-markings of continents and oceans would be made out. On Venus we saw nothing but an unbroken envelope of shifting cloud. A study by Gerascinovic in 1937 had established the fact that this envelope consisted of large scattering aggregations, probably comparable in physical state to the ice particles constituting the cirrus clouds in the Earth's atmosphere. Below this layer no spectroscopic penetration was possible and therefore no information could be obtained about the inner levels of the planet's atmosphere. The information gained about the level above the cloudy envelope, however, showed a condition in many ways the antithesis of that of our own air. The Earth's atmosphere contained about one-fifth oxygen, a considerable quantity of water vapour, and a small proportion (about 4 : 10,000) of carbon dioxide. The atmosphere of Venus showed no water vapour or oxygen, but a large proportion of carbon dioxide. It could not be assumed that Venus was entirely without oxygen; its presence might escape observation by reason of the limited penetration of the cloud envelope. In the upper atmosphere, at all events, we might conclude that the relative proportions of carbon dioxide and oxygen are the opposite of those in the Earth's atmosphere.

(To be continued.)

THE INSTITUTION OF ENGINEERS-IN-CHARGE.—The 41st annual dinner of the Institution of Engineers-in-Charge will take place on Friday, May 9, at 5.0 for 5.30 p.m., at the Holborn Restaurant, London. Further particulars and tickets will be issued in due course.

DEMOLITION OF NORTH TOWER, CRYSTAL PALACE.

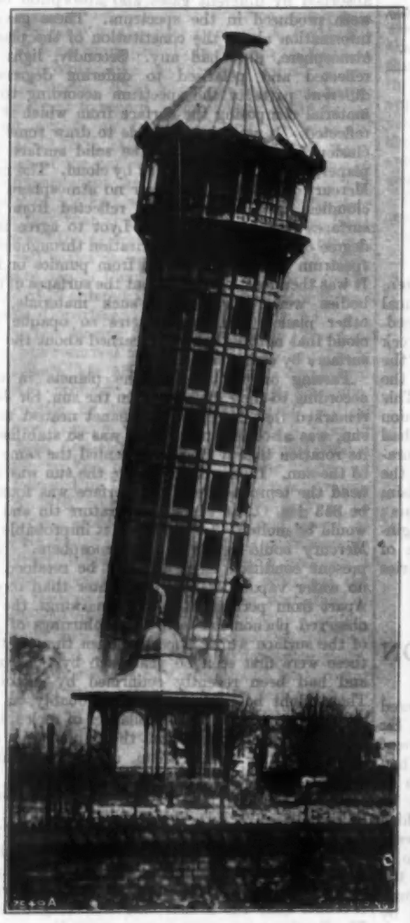


Fig. 1.

Fig. 2.

THE CRYSTAL PALACE.

On page 313 of last week's issue of Engineering, it was recorded that the North Tower of the Crystal Palace—the sole remaining part of the structure, other than such outbuildings as shelters and refreshment rooms—was to be demolished by the use of explosives on Wednesday, April 16. The illustrations herewith may serve as some memorial of a building which, while it had undoubtedly long outlived all hopes of further usefulness, was held in sentimental regard by many thousands who recalled its palmier days and by thousands more who knew it only as a landmark. Apart from any such reasons for remembrance, however, the Palace and its towers were interesting examples of a type of engineering that only the Victorian Age would have produced. It will be recalled that the main building was destroyed by fire on the night of November 30, 1936. Our issue of April 29, 1921, dealing with repairs to the building, also illustrated the details of its construction.

Originally constructed in 1850-51 in Hyde Park, where it housed the Great Exhibition, the Crystal Palace was taken down in 1852 and re-erected at Sydenham, where it was opened by Queen Victoria, for the second time, in 1854. As designed, it had no heating system, and I. K. Brunel, who was consulted regarding the provision of chimneys, for the heating plant, which should conform to the general style of the main building, designed the two towers for this purpose. He also incorporated in them the water tanks required to maintain the pressure in the mains supplying the ornamental fountains. It has been stated that the weight of the towers was intentionally made sufficient to hold them erect against any wind force likely to be experienced; this may have been so, but, in fact, they were also secured by holding-down bolts to the circular foundations, which consisted of concrete beds 3 ft. thick and 60 ft. in diameter, on which was laid a circular wall of brickwork, 56 ft. in diameter, supporting the cast-iron columns. In each tower there were ten floors, each consisting of twelve sections braced together by wrought-iron tie bars. The total height was about 280 ft. and the diameter 40 ft., and a cast-iron staircase round the central brick chimney connected the several floors. The water tank was annular in form, being supported on wrought-iron girders, radiating from the central chimney and resting at their outer ends on the main columns of the tower. In the case of the North Tower, the original tank had shown signs of weakness some years ago and a reinforced-concrete tank had been constructed inside it. As this tank weighed about 500 tons and might have complicated the task of felling the tower, it was cut out by means of pneumatic tools, the work taking about two months.

The tower was felled by blasting away, with gelignite, six of the cast-iron columns forming the lowest storey, together with the front portion of the brick flue and four of the small cast-iron columns supporting the first floor. The total weight of explosive used was 220 lb., a quantity which proved completely effective. Extensive precautions were taken by the police in case the tower fell in some unexpected direction, traffic being stopped in adjacent roads, and the occupants temporarily evacuated from neighbouring houses; but, in the event, these proved to be quite unnecessary, the tower falling as had been intended, along the terrace. Fig. 1, on this page, shows the tower about one second after the charge was detonated, Fig. 2 having been taken approximately two seconds later. The tower was estimated to contain about 840 tons of iron, 570 tons of brickwork, 74 tons of wood in the floors and the conical canopy, and about 5 tons of glass.

The South Tower could not be felled, owing to its proximity to Anerley-road, but had to be dismantled piece by piece. A protective fan or apron of planking, supported on five radial booms of steel trellis, prevented fragments from falling into the road during the process. The butt ends of the booms were supported at the fourth-floor level, and the outer ends were tied back to the tower with wire ropes. The jib used for handling the cast-iron sections of the structure, which weighed about 4¼ tons each, was mounted on the central brick flue, which served as a king post. The foot of the jib was fitted with steel rollers, bearing on a steel ring strapped round the flue. As each floor was removed, the ring was lowered down the flue to the next floor, a distance of about 20 ft., and the brickwork was broken away to within about 5 ft. of the new position. The contract for the demolition was placed with Messrs. George Cohen and Sons, Limited, in June, 1940, and the South Tower had been completely dismantled before the North Tower was felled.

The Control of Machinery, Plant and Appliances.—Under the Machinery, Plant and Appliances (Control) (No. 2) Order, 1941 (S.R. and O. 1941, No. 516), which came into force on April 17, the Machinery and Plant (Control) Order, 1940 (S.R. and O. 1940, No. 875) is so amended as to permit the supply, without licence, of machinery, plant and appliances by manufacturers and "reconditioners," provided that they carry out no act of manufacture thereon and that they have not acquired them from another manufacturer. The schedules of the machinery, plant and appliances to which the Orders relate are included in the Machinery and Plant (Control) (No. 2) Order, 1940 (S.R. and O. 1940, No. 1363) and the Machinery, Plant and Appliances (Control) Order, 1940 (S.R. and O. 1940, No. 2179). Copies of all the relevant Orders are obtainable from H.M. Stationery Office, price 1d. Explanatory notices of earlier Orders appeared in *The Board of Trade Journal* of August 1, 1940, page 75, and of January 2, 1941, page 2. Further particulars may be obtained on application to the Industrial Supplies Department (Machinery Licences Division), Board of Trade, 1-6, Tavistock-square, London, W.C.1.

DISCOVERY AND INVENTION.*

By SIR RICHARD GREGORY, Bart., F.R.S.

(*Concluded from page* 306.)

THE capacity for discovery, including invention, is stimulated by rewards which in the field of science may be of an honorary kind, but in that of invention are financial through the award of patent rights. While the motive in undertaking scientific research is still usually academic or intellectual, applications for patent rights show that an increasing number of such investigators anticipate profitable use of their discoveries and hope to share in it. Other means have been suggested for the protection of scientific achievements from exploitation for the financial benefit of a few. Among these are the establishment of an international bureau; the creation of a fund contributed to by manufacturers; and the donation of Government funds to the discoverer.

As the establishment of any scheme of this kind is at present unlikely to be adopted, the results of research that have possible commercial importance or industrial application are now usually patented. Few people would think that the discovery that the chemical element, hydrogen, contains two isotopes of different masses is of more than academic interest; yet its practical significance was soon foreseen. The "heavy hydrogen," or deuterium, can be isolated from ordinary water and forms a so-called "heavy water." This discovery was made in the United States in 1932, and two years later the British Patent Office was receiving applications relating to inventions of methods of manufacturing "heavy water" and for the production of organic compounds containing "heavy hydrogen."

Assuming that the community wishes the research worker to benefit directly from profits derived from any scientific discovery he may make, and that he claims the right to his share of them, it seems that, apart from patenting the results of research, no other practicable means for the protection of scientific discoveries is available. What constitutes a scientific discovery is, however, often very difficult to decide. Every paper accepted by a leading scientific society for publication contains the results of original work and additions to the knowledge of the subject with which it deals. The author of such a paper is expected to state clearly the object of his investigation, the methods used to attain it, and the conclusions reached. Any new fact or principle contained in a contribution of this kind is a discovery, yet many thousands of original papers are published annually by scientific societies without any claims being made to patent rights in what they reveal as to new substances or relationships. The primary purpose of research laboratories of great industrial firms is profitable invention and not the discovery of scientific principles. What is called fundamental research, having no direct practical application, is often undertaken in such laboratories and leads to valuable contributions to scientific knowledge, but the main motive is directly industrial. It is now generally recognised that systematic research is an essential part of progressive industry, whether it be of a simple "trial-and-error" kind or into basic causes and consequences of properties and processes.

Increase in the number of Government and other research laboratories led to the consideration of the rights of research workers to publish or patent discoveries or inventions made by them in the course of their employment or otherwise. An Inter-Departmental Committee on Patents was, therefore, appointed in 1921, with Sir Kenneth Lee as the chairman. The terms of reference were: (1) to consider the methods of dealing with inventions made by workers aided or maintained from public funds, whether such workers be engaged (*a*) as research workers, or (*b*) in some other technical capacity, so as to give a fair reward to the inventor and thus encourage further effort, to secure the utilisation in industry of suitable inventions, and to protect the national interest, and (2) to outline a course of procedure in respect of inventions arising out of State-aided or supported work which shall further these aims and be suitable for adoption by all Government departments concerned.

In 1925, the Civil Service Whitley Council appointed a committee to consider the report of the Lee Committee, so far as it affected inventions made by civil servants. The recommendations of these two committees were largely instrumental in determining the general policy of Government and other research laboratories with regard to discoveries or inventions made by workers in them. Most of these laboratories are organic parts of the Department of Scientific and Industrial Research or of the Industrial Research Associations connected with it. The Department's own officers are employed specifically to do research work. Patents arising from such work are dealt with by the Department, but all the proceedings are in the name of the inventor, who is consulted on questions arising during the preparation of the patent specifications, and later, if the invention is taken up by industry. The inventor gives a formal undertaking to deal with his legal rights in his invention as the Department may direct, and, when granted, the patent is usually assigned to the Imperial Trust for the Encouragement of Scientific and Industrial Research, which is a corporate body appointed to hold property for the Department. A research worker who produces an invention because of special knowledge or experience gained as a result of his being employed by the Department, but not as a direct result of work for which he is employed, is usually allowed to proceed at his own expense as a private individual in safeguarding his own interests in it. In such cases some benefits are usually reserved to the Government; particularly the right of free use by the Crown, a small proportion—about 10 per cent.—of any financial benefits, and often also the right to examine any proposed contract by the inventor from the point of view of national interests.

Patent specifications represent only a very small part of the results of scientific research carried out in Government departments. When investigations and results are considered to be of scientific value, independently of their commercial exploitation, they are recorded in departmental publications, scientific periodicals, or papers communicated to scientific societies. Research workers cannot publish results of work carried out in their official capacity except under the authority of their department, but every encouragement is given to such publication, unless the national interest requires that the results should remain secret. It is the usual practice to associate the names of research workers with any form of publication which may be adopted, so that they receive full credit for their contributions to scientific knowledge.

The practice of the Research Associations connected with the Department of Scientific and Industrial Research varies considerably in the extent to which the results are published but, in general, and to an increasing degree, these Associations follow the principle adopted by the Department. Much of the work of the Associations remains, however, confidential to the members, and on this account workers on their staffs may be deprived of the advantage of freedom of publication of results of scientific work done in the course of their employment. In the absence of any other compensations, the gain to the worker is the prestige of his position in the Research Association and in his reputation outside it. In research laboratories connected with the defence services, security requirements limit the degree of publicity permissible, but in other Government departments the chief concern seems to be to ensure that results are applied for the greatest benefit of the community.

* Aldred Lecture delivered before the Royal Society of Arts, Adelphi, London, W.C.2, on Wednesday, March 26, 1941. Abridged.

MATERIALS FOR ELECTRICAL CONTACTS.

(*Concluded from page* 317.)

FROM the account given previously it follows that if it is possible to ensure that the limiting current is not exceeded most of the troubles which result from material transfer can be avoided entirely. The value of the limiting current for material transfer when no spark-quench condenser is fitted appears, as a first approximation, to be influenced mainly by the voltage at the instant of break and by the nature of the contact material. No detailed study of the effect of voltage on the limiting current for material transfer has been made, but its effect on the current at which arc discharge starts has been studied and the results may be regarded as a guide to the general effect of voltage variations. It appears that when the voltage at break is low, appreciable currents may be broken without setting up an arc discharge, but the current that can be broken without arcing falls as the voltage rises and attains a limiting value when the potential reaches about 50 volts. Increasing the voltage to higher values has little, if any, effect on the limiting current. It is the voltage at break that determines the limiting current.

The value of the limiting current may vary very greatly with different contact materials and, in view of the importance of this value, it has been determined directly under various conditions for a number of metals and alloys. The method of testing has been to fit the contacts into small sturdily-built relays so that they are free from visible whipping or bouncing action at break. Oscillograph records confirm that the breaking action is rapid and clean cut, but the operation of making involves eight separate bounces, at each of which contact is made and broken during a time interval of about 0·02 second. A panel of twelve relays was used and the relays were operated from a storage battery by means of a motor-driven commutator. It was found that currents as little as 0·1 ampere below the limiting current would not give rise to more than 0·001 gramme of transfer after 400,000 operations, while currents 0·1 ampere above the limiting value would transfer 20 to 40 times as great a weight of material and would often cause interlocking. When full-wave rectified direct-current from a metal rectifier was employed, however, the limiting current was not nearly so sharply marked. It would appear most likely that the limiting conditions which define the commencement of material transfer are not dependent only on the value of the current but are influenced by the energy in the circuit.

As it is not always possible to operate contacts with currents below the limiting value, a knowledge of the amount of material transfer likely to occur in service is of great help in the choice of a contact material. In pure resistance circuits operated from a battery supply, it is found that 28 mg. of fine silver and about the same amount of commercial platinum and 30 per cent. iridium-platinum are lost from the negative contact after 200,000 operations at 110 volts, with the limiting current plus 0·25 ampere. In other circuits, where electrical wear is less severe, there is a more pronounced difference between the behaviour of different materials. In these conditions, the rate of transfer is proportional to the number of operations.

Choice of a contact material to interrupt heavy direct-currents at high voltage is obviously a matter of considerable difficulty, but the following general observations appear to be justified: Among the noble metals, fine silver seems to resist transfer better than any other although in some rather narrowly defined conditions (below 1 ampere with rectified direct current at 100 volts in a resistance circuit), platinum may be preferable. If the choice is broadened beyond the noble metals, tungsten becomes more valuable since it resists transfer better than any other metal or alloy. Tungsten, however, becomes coated in service with a high-resistance oxide film and the heaviest possible pressures should be used to keep contact resistance as low as possible. Tungsten, moreover, is liable to be brittle, cannot be riveted or cold worked and must be attached by copper brazing to a steel base. Among the platinum alloys the iridium-platinum, as well as the ruthenium-platinum alloys, generally resist transfer rather better than platinum. The platinum-gold-silver alloys, on the other hand, are particularly liable to transfer badly.

Among silver alloys, none of the common binary alloys, such as platinum silver, resists transfer so well as fine silver. In some conditions, however, more complex alloys appear to be markedly superior. The silver-cadmium-magnesium alloy known as Elkonium 61, has an unusually low rate of transfer with high currents under certain conditions of test. It has been suggested that in this alloy, as well as in the silver-cadmium-nickel alloy known as Elkonium 17, transfer is hindered by cadmium and other oxides which form on the contact surfaces. These oxide films have sometimes given rise to trouble through high contact resistance, but it is claimed that a combination of Elkonium 17, as the positive contact with a palladium-silver alloy known as Elkonium 11 as the negative, possesses both low rate of transfer and freedom from high-resistance films. It has been used in some railway signal relays and low-voltage regulators in America. In medium-duty circuits, the resistance to transfer of the special composite materials such as copper-tungsten, silver-molybdenum, and silver-tungsten (including those known as Elkonites) is not so great as that of tungsten, but is generally rather better than that of silver. The silver-nickel powder metallurgy products also show considerable resistance to transfer and, in some conditions, are among the best materials which have been tested.

While the amount of transfer which occurs is largely influenced by the electrical conditions in the circuit and the nature of the contact material, it may also be affected by some more or less external conditions. The pressure with which the contacts are brought together seems to have a slight effect on the nature of the build-up. Some preliminary experiments have indicated that "spikey" build-up is liable to form more readily if the contact pressure is very light. Under heavier pressures, the build-up tends to be more dome-shaped. The size of the contact may also have a minor influence. It has been found that with fine silver the current at which build-up occurs with 110 volts rectified direct current can be raised from 0·5 ampere to 0·9 ampere by increasing the diameter of the contact head from 0·128 in. to 0·375 in. To obtain these results it was necessary, however, to take great care to align the contact surfaces. The effect is most probably to increase the number of points at which true contact occurs. This explanation is supported by the observation that with currents above the limiting value, the loss of weight of the negative contact was independent of the diameter, although the height of build-up was less and better distributed. No improvements, however, appear to be obtained by increasing the head thickness (and thereby increasing the capacity for heat transfer) and build-up appears to be independent of the rate at which the contacts are operated or the speed at which they are separated. The nature

of the atmosphere surrounding the contacts may, in many cases, influence build-up considerably. The effect of humidity, which is obviously of practical concern, does not appear to have received a great deal of study, and no reliable information concerning it seems to be available. In certain applications, as in car and aero-engine magneto contacts, the action of oil and petrol vapours needs to be considered. In these conditions, platinum and platinum-alloy contacts are liable to give considerable trouble through build-up. When these materials are used, carbon readily deposits as a closely adherent film on the contact surfaces, the platinum probably acting catalytically to promote cracking of the hydrocarbon vapours. The result is, in effect, to transform the contact surfaces from platinum, for which the limiting current is high, to carbon, for which it is very low. Build-up then commences and continues with great severity.

The values quoted for the limiting current and the rate of transfer given above apply only in the absence of spark-quenching devices. In general, it is possible to reduce arcing and material transfer in direct-current circuits very considerably and often to eliminate them entirely by shunting a condenser and series resistor across the contact gap, though the values of capitance and resistance need to be carefully adjusted to meet circuit conditions. Failure due to welding of the contacts is invariably due to a current surge on make and often gives rise to considerable trouble. The obvious steps to overcome it are :—The use of a sufficiently high value of series resistance in the spark-quench circuit, the use of as high a spring pressure as possible to separate the contacts on break, and the use of a material having an inherently low tendency to weld. In order to obtain a relative measure of the welding characteristics of various materials the contacts were mounted in the relay previously described and were employed to interrupt a current of 1·6 amperes in a 110-volt rectified direct-current circuit. The contacts were shunted by a 2μF condenser in series with a variable resistor and adjusted so that the spring pressure separating the contacts was 90 gm. Welding of all contacts occurred when the resistance in series circuit was below 0·1 ohm. On increasing the value of resistance, however, the current surge at make was reduced and a value of resistance was finally obtained which was just sufficient to allow the relay to operate for at least 20 seconds without sticking. Wide variations in the capacitance of the condenser have no appreciable effect on the readings of this resistance, which is taken as a measure of the ease of welding of the contact material. It may be noted that commercial platinum and the iridium-platinum alloys are particularly prone to sticking. The 10-per cent. gold-silver alloy is slightly superior to fine silver, and this possibly accounts for the good service which this alloy has been found to give in many applications. Similarly, platinum-gold-silver is rather less susceptible to sticking than commercial platinum. The best materials are the powder metallurgy products containing tungsten, molybdenum or nickel.

In alternating-current circuits contact troubles due to material transfer are generally absent, and welding of the contacts occurs far less frequently than in direct-current circuits. Reports of build-up in alternating-current circuits have been encountered occasionally, but these may possibly be attributed to special circuit conditions, which cause the contacts to open always at the same part of the current cycle. The usual effect of alternating current is to cause a general uniform roughening of the contact faces and both contacts lose weight at a relatively low rate. For most alternating-current applications fine silver appears to be the most suitable contact material. The effect of the arc is to keep the surface relatively clean and to remove tarnish films. If, however, the utmost reliability is required, platinum contacts are probably to be preferred, since they will not tarnish if allowed to remain in the open position for prolonged periods. In choosing sliding contacts, it is generally considered that the effects of tarnish films can be neglected, since the wear between the rubbing parts will keep the contact faces clean. When very small currents are to be handled, however, the wear is not always sufficient to ensure that the lowest values of contact resistance are maintained, and it is then advisable to choose tarnish-resistant metals. The main problem is to choose two sliding-contact materials which will not wear unduly, it being noted that hardness is not always associated with the best wear resistance. In order to obtain data on the wear resistance of various combinations of metals in the absence of lubricants, a plate of one metal was pressed with a known force against a small revolving wheel of the other metal. The wheel wears a channel in the stationary plate and the length of the channel is taken as a measure of the wear. Most tests have been carried out by running at 200 r.p.m. for 20 minutes with a pressure of 100 gm. The length of channel varied from 0·3 mm. with a 15-carat gold alloy wheel and a rhodium plate to 1·3 mm. with a rhodium wheel and a fine silver plate.

LABOUR NOTES.

BETWEEN February 10 and March 17, the numbers of unemployed on the registers decreased by 22,236 in the London area, 11,233 in the Eastern area, 4,590 in the Southern area, 5,921 in the South-Western area, 9,956 in the Midlands, 10,096 in the North Midlands, 11,841 in the North-Eastern area, 8,586 in the North-Western area, 12,836 in the Northern area, 13,539 in Scotland, and 12,097 in Wales. As from March 10, there were some re-arrangements of areas in the Southern and South-Western divisions. The comparisons given relate to the divisions as now constituted.

Writing in the April issue of the Amalgamated Engineering Union's *Journal*, the Editor expresses the hope that "the Ministers responsible for the Government's manpower policy are less confused about it than are the great mass of people directly affected by it." "A spate of Orders has been issued," he says, "prescribing the registration of different classes of citizens and applying coercive measures for various forms of national service. These Orders have the average man and woman at a loss to know what they are expected to do. Few people who are not experts in the new emergency legislation would venture to say what the legal liabilities of the ordinary person in the way of national service are at the present time. We may as well make up our minds to recognise the fact that a system of compulsory service is now in existence. It extends far beyond liability for service in the Armed Forces. That already stretches further than the original Acts. There was a proclamation signed at the end of January, which extended these Acts to men who had on that date (January 29) reached the age of 18 and had not reached the age of 41. A Bill is on the way through Parliament . . . which places the Civil Defence services on the same footing as the three Armed Forces —that is to say, recruitment for the civilian services will no longer be on a voluntary basis."

After reviewing the position generally, the writer of the editorial says :—"The question that arises in our mind is where the employment is to be found in the war trades for these expanding masses of reserved labour. There are limits to the capacity of the war trades to absorb these reserves. This is particularly true of the engineering trades, because these are trades which require trained labour. Their expansion as a field of employment is conditioned by the possibility of training labour for the skilled processes. You don't enlarge the field of employment in the engineering trades by combing out young engineers of military age and substituting the labour of women or other entrants to the industry who lack the experience, the skill, and the trained aptitudes of the men who have been combed out. On the contrary, that process is calculated to limit the development of the engineering trades as a field of employment. In our view, the problem for both the Government and the engineering industry is not primarily to expand the labour force at the disposal of the engineering trades ; it is, first of all, to make the best possible use of the skilled labour the industry has had at its disposal."

"It cannot be said," the writer concludes, "that wise and prudent use has been made of our industry's most precious asset—the resources of skilled labour. It is bad national economy, in deciding whether a skilled worker should stay at his job or go into the Army, to give a bias to arrangements that will take him from his job. It is a grievous mistake of policy to treat the labour problem in the engineering industry as, in any sense, a problem of substitute labour. There is no substitute for a skilled man except another worker of equal skill. Are there many such to be found in the reserves of labour the Government is building up in the measures we have described ? "

At the close of a conference last week of the National Union of Boot and Shoe Operatives, it was stated that boot and shoe workers are to work a 48-hour, instead of a 45-hour, week until the end of the war. Overtime rates are to be paid for the extra hours. According to Mr. Chester, the general secretary of the organisation, the employers have given a written undertaking to revert to the 45-hour week, or such hours below 45 as may be agreed—after the war.

The majority of the members of the Scottish Transport and General Workers' Union who objected to the introduction, on Clydeside, of the Government's dock labour pooling plan changed their minds early last week, and decided to register—in other words, to give the scheme a three-months' trial. The executive of the organisation recommended aquiescence in the arrangement. Dock workers in both the Liverpool and the Glasgow areas are now, therefore, employees of the Ministry of Transport.

Addressing the annual Conference at York of the Co-operative Party, Mr. A. V. Alexander, the First Lord of the Admiralty, said that every hour wasted in production, every hour of slackness, every hour of argument that called workers away from their war effort, represented assistance to Hitler and his minions. Effort was needed and staying power, and he believed that we had both ; but the effort and the staying power must be continued until victory was finally won. On Tyneside, from which he had just come, he had found a great, massive, growing effort by the workers and a determination that the future should not be threatened by any lack on their part. "If this fight were lost," he declared, "there would be no future for the Co-operative movement."

The conference adopted a resolution making Communists ineligible for membership of the Co-operative Party. It rejected by an overwhelming majority the following resolution :—"The time is now opportune to demand that the Government be reconstituted and that the personnel consist of representatives whose sincerity of purpose will be welcomed by all people opposed to Nazism and Fascism."

A Michigan law making it a misdemeanour for an employer to discriminate in the payment of wages as between men and women has been held constitutional by the State Supreme Court. Under this Act, an employer who employs both men and women in the manufacture or production of any article is guilty of a misdemeanour if he pays any woman a lower wage "than is being paid to males similarly employed in such manufacture, production or in any employment formerly performed by males." The employer in this case sought to prevent the operation of the law on the ground that it was uncertain, arbitrary, and confiscatory and denied to him the equal protection of the laws. The Court ruled, however, as to the claim of uncertainty that the use of the word "similar" was not so indefinite and ambiguous as to constitute a denial of due process of law. This word was held to have a definite meaning, and as used in the Act meant "substantially alike." The Court further declared that the expression simply signified that "the employer shall not, because of her sex only, pay a woman employee less than he pays a man employee for doing work of substantially the same character, quality and quantity."

In answering the objection to the phrase that the law applied to "any employment formerly performed by males," the Court ruled that such phrase did not inject any uncertainty as to an employer who had employed both men and women for a number of years. Dealing with the objection that the classification of employments in the law denied equal protection to the employer, the Court ruled that the evil sought to be eradicated was discrimination against women, and the employer could not complain merely because the legislation attempted to remedy only a part of the problem. In the course of its opinion, the Court held also that the statute was not arbitrary nor confiscatory, and that the Act was not unconstitutional because employers in the same locality might be required to pay different wages to women employees for the same work.

The latest official *Trade Report* of the United Pattern-makers' Association states that the membership of the organisation is now 12,749. The number of members in receipt of sick benefit increased in March from 295 to 327, and the number of superannuated members decreased from 677 to 674.

The International Labour Review, a publication of the International Labour Office, formerly of Geneva and now of Montreal, Canada, says that in the course of an article on the Norwegian trade-union movement during the German occupation, the organ of the Swedish Confederation of Trade Unions notes that the German authorities have issued orders absolutely prohibiting wage increases and compensation for rises in the cost of living, even in cases where the measure is the result of an agreement between employers and workers. These orders are stated to be in conformity with the principles laid down by Carlo Otte, leader of the economic section under the German Commissioner at Oslo, who recently said, amongst other things, that he considered it to be one of the most important tasks of the future to increase labour output and reduce wages considerably wherever wage increases which were fatal to economic life had been achieved as a result of strike action by trade unions. In the long run, an adjustment of prices to the level in Central Europe would become necessary. In that way, Otte claimed, with the lowering of prices and of real wages, and therefore of the standard of living, the necessary conditions would, one day, be created for the incorporation of the Norwegian economy in the European economic system.

PROXIMATE ANALYSIS AND COAL BEHAVIOUR.*

By J. G. BENNETT.

(*Concluded from page* 320.)

IN the higher-rank coals, there is no softening at the temperatures for which this effect appears for bituminous coal; but in the fuel bed, where much higher temperatures are encountered, even the slightest tendency to soften may have a marked influence upon the behaviour of the fuel. Steam coals below about 12 per cent. volatile are used in gravity-feed appliances, but unless carefully selected, those near the upper limit are liable to give trouble through cohering of the particles. At this point, in fact, we see the onset of softening resulting in cementation of the particles without actual fusion. In Table III, herewith, Dr. Seyler has summarised the coking properties of nearly 300 samples of Welsh steam coal, grouped into seven coking classes.

TABLE III.—COKING PROPERTIES AND VOLATILE CONTENT.

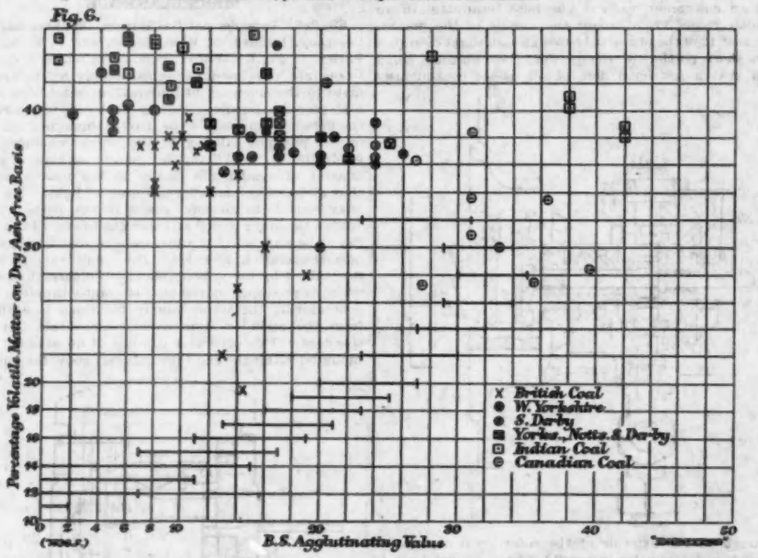
Volatile Per Cent. (Parr's Basis).	Total Number of Samples.	Coking Class. 1.	2.	3.	4.	5.	6.
11—12 ..	32	16=50 %	12=37·5 %	4=12·5 %	—	—	—
12—13 ..	51	10=19·6 %	10=19·6 %	21=41·2 %	10=19·6 %	—	—
13—14 ..	144	—	—	28=19·4 %	116=80·6 %	—	—
14—15 ..	52	—	—	6=11·5 %	46=88·5 %	—	—
15—18 ..	9	—	—	—	—	9=100 %	—
18 and over	3	—	—	—	—	—	2=100 %

COKING CLASS.

The coal of size ¼ in. to ⅛ in. was heated in a platinum crucible to 900 deg. C. as in the B.S.I. volatile test, and the character of the residue noted.

Class 0 .. Particles quite discrete.
" 1 .. A few particles only cohere.
" 2 .. Particles slightly coherent.
" 3 .. Particles cohere but are visible.
" 4 .. Particles cohere and a dendritic or tree-like formation due to swelling takes place.
" 5 .. No dendritic formation, particles cohere but are still visible on the surface.
" 6 .. No dendritic formation, particles no longer visible on the surface.

Fig. 6.



It will be seen that, in the group 12 per cent. to 13 per cent. volatile, there is a broad spread of caking properties, from absence of all caking to caking plus swelling. The peculiar property of swelling without softening is almost entirely confined to the narrow range of 13 per cent. to 15 per cent. volatiles. It is clear that, having regard to errors in sampling and analysis, the prediction of this particular swelling property from the proximate analysis would be highly dangerous, and the only safe course is to observe and specify this property separately.

The best confirmation of the views I have put forward is found in Fig. 6, herewith, showing the connection between agglutinating power and volatile content. In this figure, the band has been constructed from data supplied for South Wales coal by Dr. Idris Jones.

TABLE IV.—*Volatile Displacement of Durain.*

Sample No.	Ultimate Analysis. Hydrogen.	Carbon.	Volatile as Measured.	Volatile Calc. from Eqn. (1).	Volatile Displacement δv.
1	4·32	90·52	19·87	17·74	2·13
2	4·94	88·47	30·70	26·86	3·84
3	4·95	86·59	32·33	29·42	2·91
4	5·43	86·83	38·17	34·09	4·08
5	4·17	82·94	30·96	25·54	5·42
6	5·01	88·80	32·68	27·20	5·48
7	5·39	86·52	39·63	34·06	5·57
8	4·31	81·93	34·24	28·16	6·08
9	4·56	84·45	34·20	27·81	6·39
10	5·02	84·40	39·40	32·75	6·65
11	4·98	82·00	43·08	35·31	7·77
12	5·61	86·07	45·31	36·93	8·38

TABLE V.—VOLATILE AUGMENTATION IN OXIDISED COALS.

	M.	V.M. (Dry).	Ash (Dry).	—	C.	H.	O.	N.	Coking Properties.
Freshly mined	0·95	25·18	9·60	Dry ..	78·81	4·58	3·13	1·58	Woodall-Duckham .. 9
				Parr's ..	89·13	5·12	3·96	1·79	
Oxidised (106 hours) ..	2·78	28·11	8·81	Dry ..	71·26	3·11	13·14	1·55	
				Parr's ..	79·79	3·42	15·05	1·74	" " .. 0
Freshly mined	0·88	17·84	6·93	Dry ..	83·67	4·15	3·05	1·23	
				Parr's ..	90·97	4·46	3·23	1·34	" " .. 7
Oxidised (94 hours) ..	2·22	21·61	6·50	Dry ..	79·39	3·51	8·60	1·04	
				Parr's ..	85·87	3·74	9·27	1·12	" " .. 0

The various agglutinating tests in general use are derived from the method proposed by Campredon and subsequently improved by various workers until finally it was standardised by the British Standards Institution in B.S.S. No. 705. The agglutinating test consists in determining the maximum quantity of inert material—a sand of carefully controlled characteristics—which will form a coherent lump when heated with unit quantity of the coal under test. The test itself has been severely criticised on account of the difficulty of obtaining consistent results by different workers and different laboratories. Nevertheless, allowing for a considerable margin of error, the sand test does give a measure of the extent to which a coal becomes fluid before it decomposes.

We have taken coals as forming a continuous sequence from low to high rank, and have tacitly assumed that the volatile content, if accurately determined, can be regarded as a measure of rank. This assumption is, unfortunately, not justified. Coal contains at least three different constituents—vitrain, durain, and fusain—which have different volatile contents for the same rank. These constituents were first pointed out by Stopes nearly 30 years ago as the visible banded constituents of bituminous coal. Since then the Stopes classification has proved invaluable for interpreting the properties and behaviour of coal. Seyler has shown that the petrological constituents must be distinguished before any correlation can be made between proximate and ultimate analysis, and it follows that this distinction is also necessary before any reliable prediction of behaviour from proximate analysis is possible. Seyler's Gold Medal papers to the South Wales Institute of Engineers show that, for any given coal, the volatile content of the durain and the vitrain are different. The volatile content of durain is always higher than that of vitrain for coals of the same elementary composition. Whereas the volatile content of a pure vitrain can be calculated without much error from the ultimate analysis by the formula :—

$$V = 10{\cdot}6\,H - 1{\cdot}24\,C + 84{\cdot}15 \quad . \quad . \quad (1)$$

this formula, for durain, must be replaced by :—

$$V = 10{\cdot}6\,H - 1{\cdot}24\,C + 84{\cdot}15 + \delta v. \quad (2)$$

δv is called by Seyler the "volatile displacement," and its amount for various durains is given in Table IV.

It will be obvious that for coals high in durain—that is, for "dull" coals—the volatile content is likely to have quite a different significance from that of bright coals of the same rank. Fusain, on the other hand, has a very much lower volatile content than the associated vitrain. We are thus obliged to accept Seyler's view that the proximate analysis is of little value as a guide to behaviour unless we know whether we are dealing with a bright or dull coal or with one high in fusain. Since British coals below about 20 per cent. volatile are nearly always bright coals, the uncertainties arising from ignorance of the petrographic constitution are not important in this range.

A second disturbing factor is the weathering or oxidation of the coal. The coking properties of coal are completely changed when it is exposed to prolonged oxidation. This is particularly the case when coals are slightly heated, as, for example, in a ship's hold. Dr. Seyler has kindly sent me data for two coals showing how the volatile content and the coking properties change on oxidation. It will be seen from Table V, herewith, that the two coals, though strongly coking by the Woodall-Duckham test when freshly mined, completely lost all coking powers after 100 hours' oxidation at 100 deg. C. There was a certain change in the volatile content, but quite insufficient to predict that the coals would not make a cohesive coke. This is an extreme case, but the effect is very noticeable in ordinary commercial practice. The difference can be observed not only when coals are weathered by prolonged exposure on the surface, but also in comparing coals mined near the outcrop with those from deeper portions of the same seam.

I do not think that I can state the conclusions which I wish you to draw from the data I have put before you better than a recent letter from Dr. Seyler, who says :—"My general conclusion is that, up to about 26 per cent. volatile matter, a fairly good general correlation with the properties can be made from the volatile matter provided the coal is a bright unoxidised one, a fact which is not revealed by the volatile determination alone, but is by the complete analysis. Beyond about 26 per cent., the volatile matter alone appears to me to be of very little value for accurate prediction of the properties. From the complete analysis (elementary volatile and calorific value) and petrological analysis a fairly good prediction can usually be made. Since, however, the conditions of the practical utilisation of coal vary so enormously, it appears necessary to supplement analytical methods by *ad hoc* laboratory tests appropriate to the actual conditions of practice."

The proximate analysis is a survival of the days of hand-firing. For the selection of coals for this purpose, it is quite adequate, but it is essentially inappropriate

* Paper entitled "How Far is the Proximate Analysis a Reliable Guide to Coal Behaviour?" read before the Institute of Fuel, in London, on April 3, 1941. Abridged.

for the purposes of mechanical firing. Various attempts have been made to supplement it by special tests developed by the carbonisation industries for their own needs. There are really no tests of the suitability of coals for mechanical stoking except actual trial in a boiler or furnace. The result is that the makers of mechanical firing equipment are very largely dependent on the specialised experience of their own combustion engineers to help their clients in the selection of plant and fuels. Small underfeed stokers already tax to the limit the knowledge and experience of engineers, and no one would think seriously of relying on proximate analysis to decide whether a given coal was suitable for such stokers or not. The same to a great extent applies to the large multiple-retort stokers used to fire some of the most important power-station boilers in this country.

In recent years we have put a great deal of work into the improvement of analytical methods without asking ourselves enough about the interpretation of the results. This applies with special force to the proximate analysis, and we ought to turn our attention in the future to the development of small-scale combustion tests which will permit a rational classification of fuels in terms of their actual performance.

BRITISH STANDARD GLOSSARY OF AERONAUTICAL TERMS.

WHEN war broke out early in September, 1939, the work of revising the 1933 edition of the British Standard Glossary of Aeronautical Terms (B.S. 185) had been practically completed by the Nomenclature Committee, under the chairmanship of Lieut.-Colonel W. Lockwood Marsh, O.B.E. In normal circumstances, the revised draft would have been circulated to the constituent bodies represented on the committee for comment and then reviewed, with these comments in mind, before publication. Under war conditions, however, it was impracticable to undertake the final review, and it was accordingly decided to issue the revised *Glossary* as a provisional edition, so that it should be available as soon as possible to the new personnel entering the aircraft industry. For the work of revision, specialists in the various branches of the subject were asked to assist the Nomenclature Committee, and the revised edition is now obtainable from the Publications Department of the British Standards Institution, 28, Victoria-street, London, S.W.1, price 8*s.*, postage paid, but users are invited to make comments and suggestions for the improvement of future editions. The *Glossary* is divided into 12 sections, covering aeronautics (general), the general motion of aircraft, aerodynamics, aerodynes (heavier than air aircraft), aerostats (lighter than air aircraft), power plant, airscrews, radial rotors, navigation, instruments and equipment, radio-communication, parachutes, ground organisation and meteorology; aerodynamic symbols and notation are dealt with in an appendix. Numerous illustrations, including six folding plates, are incorporated in the *Glossary* to assist the user in identifying and locating the parts named and in understanding the terms employed. The illustrations show all types of heavier than air aircraft, rigid and non-rigid airships, free and kite balloons, the main parts of aero engines, the layout of an aerodrome, the lighting of airways and aerodromes, and a typical weather chart.

CATALOGUES.

Electric Motors.—We have received from Messrs. Newman Industries, Limited, Yate, Bristol, a stock list of motors, of all the leading makes, for direct or alternating current.

Insulating Tape.—Messrs. British Insulated Cables, Limited, Prescot, Lancashire, have sent us a leaflet giving particulars of their plastic "Pernax" brand insulating tape, which is for use out of doors, especially in corrosive atmospheres.

Folding Machines for Sheet Metal.—Leaflets received from Messrs. F. J. Edwards, Limited, 359-361, Euston-road, London, N.W.1, describe their "Besco" range of machines for edging and bending sheet metal; also a cramp folding machine which is open-ended, allowing sheets of unlimited length to be bent.

Rotary Dryers.—Messrs. Sturtevant Engineering Company, Limited, 147, Queen Victoria-street, London, E.C.4, have sent us a copy of their Publication No. 1822, which deals with rotary dryers. Illustrations show the application of these dryers to suit varying conditions and materials, and the advantage of drying before fine grinding is briefly discussed.

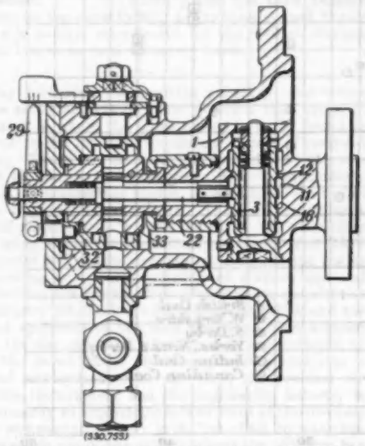
"ENGINEERING" ILLUSTRATED PATENT RECORD.

ABSTRACTS OF SPECIFICATIONS RECENTLY PUBLISHED UNDER THE ACTS OF 1907 TO 1939.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned, the Specification is not illustrated.
Where inventions are communicated from abroad, the Names, etc., of the Communicators are given in italics.
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery-lane, London, W.C.2, price 1s. each.
The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.
Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

HYDRAULIC APPARATUS.

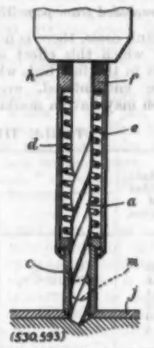
530,755. Turbine-Rotor Control. Cockburns, Limited, of Cardonald, J. Rodger, and T. Grant, of Cardonald. (1 *Fig.*) July 3, 1939.—The invention is a device for controlling the speed and end-play of a turbine rotor, and embodies a centrifugal trip valve in a hydraulic control circuit. A rotor 1 is coupled to the turbine rotor and has a diametral cylindrical pocket, and this pocket houses a hollow spring-loaded piston valve 3, which is normally held closed. The centre of gravity of the valve is eccentric to the axis of the rotor 1, and the valve spring is adjusted so that the valve opens quickly above a certain speed. The rotor 1 is bored with a passage for oil under pressure and is connected to a cylinder controlling an emergency valve. The bore terminates in an annular recess 11, at about the middle of the pocket. One beat 12 of the piston valve works with slight clearance in a short portion of the pocket, the clearance being such that a restricted flow of oil passes continuously



through to the exterior of the rotor. Oil also passes continuously from the recess 11 past a second beat 16 of the valve to the exterior of the rotor. This normal continuous flow of oil maintains the working surfaces of the valve free from "gum." When a predetermined maximum speed of rotation is exceeded, the valve 3 trips rapidly to the full-open position, and the emergency valve is quickly closed by the sudden release of oil pressure from one end of its slave cylinder. When the valve 3 trips to the full-open position, a valve-detent rod 22 snaps under a collar on the valve to retain it in the open position. The outer end of the rod 22 passes through a stationary ported sleeve, which follows any endwise movement of the rotor and protrudes from the end cover of the housing, where it is pinned to a fore-and-aft movement indicator lever 29. A lantern-valve 33 on the sleeve registers with a valve liner 32, which is adjustable to maintain the proper endwise setting relatively to the valve 33. Should the turbine rotor develop excess end-play, the valve 33 releases oil from the bore of the rotor and closes the emergency valve. (*Accepted December* 19, 1940.)

MACHINE TOOLS AND MACHINE-SHOP EQUIPMENT.

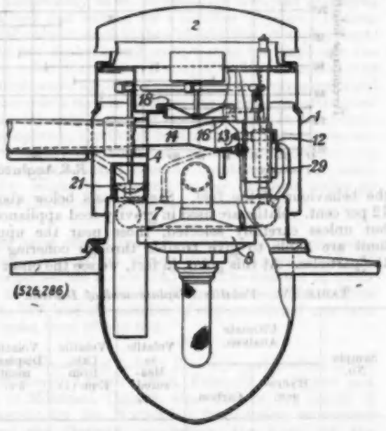
530,593. Twist-Drill Steady. A. V. Roe and Company, Limited, of Manchester, and R. F. Taylor, of Manchester. (1 *Fig.*) June 28, 1939.—The invention is a twist-drill steady for use in machines employing twist drills of relatively small diameter, which are liable to become stressed unduly and fractured during drilling, especially when the drill breaks through. The twist drill *a* is held in the usual type of holder and is surrounded by telescopic tubes *c*, *d*. The tube *c* is loaded by a compression spring *e*, and is a free fit upon the twist drill, as is also the bore of the internal collar *f*, and a spring or vulcanite ring *h* prevents the device from sliding off the drill; it also ensures that the tubes *c* and *d* revolve with the drill. The end of the tube *c* is coned to act as a guide when drilling through a jig *j*. There is a hole



through the tube *c* at *m*. The twist drill is thus effectively supported during the drilling operation and the spring-loaded tube *c* provides a resilient abutment to take up shock when the drill breaks through. The telescopic tubes, by preventing drill deflection, also obviate lateral enlargement of the drilled hole by the drill when it breaks through. (*Accepted December* 16, 1940.)

MISCELLANEOUS.

526,286. Incandescent Gas Burner. William Sugg and Company, Limited, of Westminster, and P. C. Sugg, of Purley. (1 *Fig.*) March 11, 1939.—The burner is designed to operate on a low-pressure gas supply but to approximate to the efficiency of illumination obtainable with a high-pressure burner. This is achieved by increasing the pressure drop across the mantle through a reduction in the pressure existing in the burner chamber, thus producing a "pull" on the mantle so that a greater amount of combustion occurs at the mantle surface, thus giving a greater concentration of light. The lamp body consists of an outer casing in two parts 1 and 2. Within the lower part is an inner flue casing 4 from which the globe and reflector are suspended and which, during normal operation, is sealed. The "pull" on the mantle is obtained by the velocity energy of a current of steam, which is produced by the heat of combustion in a steam generator 7, the water supply to which is automatic from the main or from a reservoir within the lamp standard. This generator consists of an annular vessel mounted within the flue 4 immediately above the burner 8,



which is of the ordinary atmospheric type, so that it is directly heated by the products of combustion and also by radiation from the burner itself. The steam generated is passed through a filter chamber 12 to a nozzle 13 in the open end of a Venturi tube 14 mounted within the flue 4, the other end of which discharges to the atmosphere. The Venturi tube has a top opening 16 into which the products of combustion are drawn so that the interior of the globe and flue are subjected to a suction which produces the required pressure drop across the mantle. When the lamp is first lit, the pressure within the globe is atmospheric, and a supply of secondary air is required to support combustion and to prevent blow-back. This air is admitted through a valve 21, the products of combustion escaping from the flue through an upper valve 18. A cylinder 29 is connected to the generator through a steam pipe, and within it is a bellows which, when the steam pressure is sufficient, closes the valves 18 and 21. The lamp thus automatically changes over to function as a high-pressure lamp. (*Accepted September* 13, 1940.